THE INTERACTION OF CREDIT, INSURANCE AND RELATIVE PRICES ON TECHNOLOGY ADOPTION

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1. Introduction

The adoption of input and management intensive technologies is advocated primarily as a way to increase small farmers' income. Nevertheless, the diffusion and adoption process has been rather slow and costly. Uncertainty in yields and prices and farmers' attitudes towards risk have been recognized as important factors to inhibit borrowing, investment and hence the adoption of technology.[1]

Uncertainty in yields is understandably a limitation for technology adoption. It is well demonstrated that under uncertainty, economically optimum use of improved seeds and fertilizers could well be at zero levels; hence the justified use of traditional technologies. If yield uncertainty was managed through a well understood crop insurance program, farmers would be more willing to adopt. Yet, farmers, as conservative and as suspicious as they are of government programs, may still hesitate before taking insurance, even when this is offered at a very low (subsidized) premium.

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The existence of crop insurance guarantees income if there is a crop disaster. Therefore, it offers a compensation only when yields are below expected levels. In such case, insurance indirectly offers protection against price risk, as the crop coverage is calculated on the basis of an expected price. However, in spatially isolated markets and in the case of non perishable products, insurance that induces technical adoption and results in higher yields (and acreages planted) may contribute to lower incomes because of excess supply which lower market prices. In such case, if there is not crop loss, insurance does not offer any guarantee of price.

A third point relates to the area substitution effect induced by insurance. Increased income expectations on the insured, presumably riskier and more profitable crop, could result in area expansion at the expense of other less profitable, but also less risky crops. Yet, if there are no disasters, the expansion of the insured crop to be sold at a lower than anticipated price may have a pervasive effect on farm income. This would be the case because of lost opportunities on other crops for which prices have increased because of a decline in production

2. Crop Credit Insurance (CCI) in Bolivia

CCI was offered first in Bolivia for potato production among farmers in Cochabamba in 1980/81.[2] The public sector insurer (ASBA) offered protection to the credit issued by the public

bank (BAB) for the production of potatoes under the technology recommended by the government institute of agricultural technology (IBTA). Without insurance BAB would have not issued the credit; but also without insurance and credit, farmers would have not used IBTA's technology.

The insurance program guarantees that if crop failure occurs, the farmers' debt with BAB is paid by ASBA. The indemnities are for the amount disbursed by BAB, and for other investment supplied by farmers (such as organic fertilizer) plus a compensation that the farmer receives for the value of his time (priced at the market wage).[3] Hence, under total loss the farmer would receive not the value of the harvest, but the total value of his labor and other costs. His debt will be paid to the bank.

The area were the program was developed and implemented in 1980/81 and 1981/82 is not atypical of highland-semicommercial agriculture in Latin America. It should not be taken by any means as representative of a backward underdeveloped agriculture in remote places in Bolivia. The area is serviced by a paved road and some of the farms are less than 30 minutes walking distance from this road, however others are faraway.[4] Average temperatures are mild; however, over the past 11 years the average minimum has been 23°F (-4,5°C); hence the probabilities of frost and hail are significant. The average annual rainfall (over 17 years) is of 713.5 mm.; yet periods of long drought are possible. The combined effects of drought and frost expose the

crops to high yield risks; yet the severity varies among farms depending on their altitude and the direction of the winds.

The average size of crop land is of 1.3 hectares[5] per farm; of which potatoes account for approximately 56 percent of the area. Potatoes (Solanum Andigenum) are grown by all farmers. Other important crops are broad beans (Vicia Faba), barley (Hordeum Vulgare), wheat (Treticum sp), oca (Oxalis Tuberosa), papaliza (Ullucus Tuberosum), and onions. Potatoes are produced for home consumption (20%) and as a cash crop. Very few farmers grow onions, the most profitable and most (price) risky crop. In the area of Melga, Cochabamba, some of the farmers can have two potato crops. If they have access to irrigation an early potato crop (misca) can be farmed. The misca potato crop is grown in part in the winter, making it susceptible to frost. The rain-fed cycle of potato, October-May (año) is the most important, making up 64% of the total area planted to potato. The experimental credit insurance has been offered only for rain-fed potato plantings.

3. Credit Insurance Research

This study was undertaken as part of a comprehensive 'research in situ' about agricultural credit insurance in Latin America carried by IICA with USAID finance. The research has addressed the issue of farm level effects of insurance (Hazell and Arcia, 1982) as well as the managerial aspects and financial viability of insurance (Pomareda, 1982; Arcia, 1982) and the

impact on the administration of bank credit (Pomareda, 1982). In the case of Bolivia, the farm level analysis had the explicit purpose of evaluating the combined effect of credit, insurance, prices and technical assistance on the adoption of technology and farmer's income. This was made possible by data obtained over three years among insured and non-insured farmers.

The surveys' samples are summarized in Table 1. A quite unfortunately lack of planning in the sampling procedures did not allow a more symmetric set. In 1980, 122 farmers were surveyed to determine their characteristics before the beginning of the insurance program. Out of the original sample 38 farmers were insured and surveyed in 1981; 48 did not opt for insurance but were surveyed and 36 farmers were not surveyed. The most interesting translocation of farmers among groups took place in 1982. From the 38 insured farmers in 1981, 15 took insurance for the second time, 7 did not take insurance[6] and 16 were not surveyed. The following paragraphs describe the main results of the surveys, providing a comparative analysis of performance of groups over time.

The 1979/80 crop cycle was described by farmers as a fair year. Rainfall was close to average and opportune. Freezing temperatures occurred for very short periods of time, not at critical points in the crop cycle. Nevertheless, as shown in Table 2, yield of potatoes was rather low in comparison with other parts of the world (CIP, 1980). Low yields are the result of using

a traditional technology, typified mainly by a low quality seed; and very spare use of chemicals for controlling nematodes and diseases; however, farmers used relatively high levels of organic and chemical fertilizers.

The improved technology was introduced in the 1980/81 crop cycle. This was described as a good year and practically no farmers reported major crop failures; neither did ASBA pay indemnities. In comparison with the previous year, farmers using the traditional technology reported yields that were 29% higher, although there were not significant changes in the levels of input use. Gross income was higher, but due to increased input prices, net income increased slightly.

The 'new' technology was typified fundamentally by an increased amount of seed of improved quality[7]; slightly less organic fertilizer and more chemical fertilizer, insecticides and fungicides. An important component of production costs was the interest cost of credit and the insurance premium. The impact of the technology on yields was dramatic as these were of 14,680 kg/ha. compared with 9,613 kg/ha. obtained by farmers using the traditional technology. Net income was, therefore, more than four times that received by farmers using the traditional technology. An important determinant of this larger income was the increased proportion of grade 1 potatoes, sold at a higher price.

Up to this point the benefits of the program (in a good year) were unquestionable. Nevertheless, it must be recalled that prices were to a great extent warranteed by the rapid move of ASBA's staff to contact truckers who purchased the excess production. This allowed the producers to sell their marketable surpluses without delay and at a fair price. As shown in Table 3 however, the potato prices in 1981 were lower than in the previous year.

The 1981/82 crop cycle was a poor one. ASBA insured 56 producers (in Melga) and received premiums for B/103 056[8]. In comparison with 1980/81, when no indemnities were paid, this last year ASBA's indemnities totaled B/215 719, hence a lost ratio of 2.09; however, the accumulative lost ratio for the last two years was lower (1.4). The relatively poor year was reflected in a decline in yields of insured and non-insured producers with a more severe impact on the first group. Yield of potatoes of non-insured producers using the traditional technology declined by 29.3 percent; but that of insured producers using the modern technology declined by 44.1 percent. This affirms the assertion that modern technologies perform more poorly than traditional ones under "less optimal weather conditions."

The significant drop in yields was apparently compensated for by a large increase in market prices. This increase was due to inflation on one hand and to a decline in supply on the other.

Interestingly, the net income[9] of non-insured producers increased with respect to the previous year, while that of insured producers declined. Furthermore, the net income of insured producers was (on the average) increased by almost 50 percent by the insurance indemnities and thus providing the insured farmers with net income after indemnity payments of B/8,928 compared to B/7,784. Obviously, if the impact of disasters on crop yields would have been more serious, insured farmers would have received larger benefits from insurance and hence their incomes would have been larger, and the ones of non-insured producers would have been smaller.

A group of producers that in 1980/81 participated in the program, decided to invest their own resources (go on their own) for the 1981/82 crop year, hence they did not insured their investment and did not borrow from BAB. Their performance on potato production is shown in the last column of Table 2. In comparison with insured farmers, the independent group reported smaller amounts of all inputs except for chemical fertilizers.[10] This could be indicative of a learning process through which they identified a larger marginal productivity of chemical fertilizers than that of other inputs. These farmers apparently saved on all inputs, but their main reduction in cost was from not paying interest on borrowed funds, insurance premium[11] and less amount of labor.

Table 1. Structure of the Samples among Insured and not Insured Farmers.

Class	Technology	1979/80	1980/81	1981/82
Not Insured	Traditional	122	48	58
	Modern	-	-	7
Insured	Modern	-	38	33
Total		122	86	98

Table 2. Resource Use, Yields and Income from Potato Production among Insured and not Insured Farmers, 1979-80 - 1981-82 Per Hectare.

Variable	Non-Insured Farmers with Traditional Technology		Non-Insured Farmers With Traditional Technology				Insured Farmers				Farmers Insured in 1980/81 But not Insured in 1981/82	
	1979/80 (n = 122)		1980/81 (n = 48)		1981/82 (n = 58)		1980/81 (n = 38)		1981/82 (n = 33)		(n = 7)	
Production Cost	Unit	$b	Unit	$b	Unit	$b	Unit	$b	Unit	$b	Unit	$b
- Yunta (DS/Yta)	24	2 625	23	3 455	25	3 685	25	3 797	27	3 992	18	2 748
- Labor (DS/1)	141	10 567	112	10 571	151	14 197	142	13 339	144	13 501	99	9 317
- Seed (Cargas)	10	7 262	8	7 528	11	8 324	12	9 191	15	11 438	33	10 176
- Organic Fertilizer (Quintales)	234	8 813	264	10 128	186	7 160	212	8 059	244	8 627	151	5 613
- Chemical Fertilizer	-	2 818	-	3 157	-	3 296	-	4 436	-	3 721	-	4 143
- Insecticides and Fungicides	-	676	-	828	-	946	-	2 790	-	1 997	-	1 104
- Interest and Prime	-	-	-	-	-	-	-	3 034	-	5 847	-	-
- Other	-	-	-	-	-	130	-	-	-	-	-	466
Total Cost		32 761		35 667		37 738		44 646		49 123		33 567
Yield and Income	Kg (%)	$b	Kg (%)	$b	Kg (%)	$b	kg (%)	$b	kg (%)	$b	kg (%)	$b
1°	2 793 (37.60)[1/]	16 199	3 759 (39.11)	18 795	2 453 (36.09)	22 494	6 588 (44.88)	32 940	2 980 (36.35)	27 327	2 942 (40.57)	26 978
2°	2 541 (34.20)	12 197	3 097 (32.22)	12 388	2 459 (36.19)	16 254	4 386 (29.88)	17 544	2 856 (34.84)	18 876	2 967 (40.91)	19 612
3°	1 660 (22.34)	6 308	2 325 (24.18)	6 975	1 393 (20.49)	6 282	2 726 (18.57)	8 178	1 364 (16.64)	6 152	1 117 (15.40)	5 038
4°	435 (5.86)	435	432 (4.49)	432	492 (7.24)	492	980 (6.67)	980	998 (12.17)	998	226 (3.12)	226
Total Yield	7 429 (100.00)		9 613 (100.00		6 797 (100.00)		14 680 (100.00)		8 198 (100.00)		7 252 (100.00)	
Gross Income		35 139		38 [illegible]		45 522		59 642		53 353		51 854
- Net Income Before Indemnities		2 378		2 923		7 784		14 996		4 230		18 287
- Insurance Indemnities		-		-		-		-		4 698[2/]		-
Net Income		2 378		2 923		7 784		14 996		8 928		18 287

[1/] These percentages are the average of non-insured farmers of 1980/81 and 1981/82.

[2/] Mean indemnity paid, (215 719/56) then transformed to a hectare by dividing it by 0.82.

Variable	Non-Insured Farmers with Traditional Technology	Non-Insured Farmers with Traditional Technology		Insured Farmers	
	1979/80 (n = 122)	1980/81 (n = 48)	1981/82 (n = 58)	1980/81 (n = 38)	1981/82 (n = 33)
Areas Planted					
Potatoes[1/] (año)	0.54	0.55	0.61	0.73	0.82
Broad beans	0.25	0.20	0.14	0.18	0.21
Barley	-	-	-	-	-
Prices B/kg					
Potatoes:					
1°	5.80	5.00	9.17	5.00	9.17
2°	4.80	4.00	6.61	4.00	6.61
3°	3.80	3.00	4.51	3.00	4.51
Discard	1.00	1.00	1.00	1.00	1.00
Broad beans	5.71	5.71	11.24	5.71	11.24
Barley	7.39	7.39	11.09	7.39	11.09
Farm Net Income[2/]					
Potatoes	1 284	1 608	4 748	10 947	7 321
Broad beans	n. a.	622	2 225	613	2 918
Barley	n. a.	466	813	1 450	949
Other crops	n. a.	1 927	1 875	487	2 369
Total	n. a.	4 623[4/]	9 661	13 497[4/]	13 557
Price Index[3/]	100.00	141.81	191.26	141.81	191.26
Farm Net Real Income	n. a.	3 260	5 051	9 518	7 088

[1/] Some farmers in this area, that have access to irrigation land, can have an early produce (misca) and a rain-fed (año).

[2/] Includes only agricultural income, and income from potato misca is excluded. The following crops were included in computing net income: potatoes (año), broad beans, barley, wheat, oca, papaliza and onion.

[3/] Period June year t/June year t+1.

[4/] Approximated data, without the last adjustment.

The total yield obtained by independent producers was between that of non-insured and insured farmers; but because of the important reduction in costs, their net income was almost double that of the insured producers. A tentative conclusion from this later analysis is that the availability of credit to farmers may induce excess use of inputs (i.e. organic fertilizer), even when expected income risk is reduced through insurance.

The real net farm income was higher for the group using credit-technology-insurance package by 292% (1980-81) and 140% (1981-82). As shown in table 3. A higher percentage of farm income comes from potato farming for the insured group (68%) compared to non insured (42%).

4. Conclusions

Several interesting, but tentative, conclusions can be drawn from this study. First, input intensive technology dramatically increases potato yields in highland rain-fed agriculture in relatively good years such as 1980-81. Even in poor years (1981-82), the yields of farmers using input-intensive technology are slightly higher than those of traditional technology. The adoption of this technology was greatly facilitated by the existence of the credit-technology-insurance package.

Second, farmers showed a willingness to continue utilizing most of the technology even when official credit was not available. We assume that farmers either invested their own

"mattress money" or borrowed from informal lenders. In either case due to a lack of data we have not been able to calculate an opportunity cost for this investment. Thus, the income of farmers in the last column of Table 2 is overstated, we would estimate by 30-40%, which is either the interest rate farmers could earn by investing these savings in non-agricultural activities or, alternatively, the interest rate charged by informal lenders.

Third, our data seems to indicate that the credit-technology-insurance package offers sufficient incentive to expand the area planted to potatoes by 30%-35%. Thus, this "package" would appear a useful policy to increase production and productivity in crops whose yields are insufficient to meet demand. Conversely we would expect little to be gained (for the farmer) by offering insurance for crops produced in adequate quantities to meet demand. The consumer, however, might benefit from lower prices.

Although our data set is quite limited, it would appear that CCI when properly implemented is useful as an income stabilization policy. Farmer's incomes are far more predictable under insurance than without it. One would consequently expect that in an actuarially fair insurance scheme, insured farmers would enjoy higher net incomes in bad years (due to indemnity payments) although non-insured farmers would receive larger net incomes in good years.[12] The choice then for the farmers is to decide between dramatic income fluctuations by not insuring or, alternatively,

opt for a steady income stream by using insurance to transfer some of the profits the farmer would have realized in good years to bad years, in which his income is not sufficient to meet his debt obligations. The latter alternative would appear to us to be preferable as it promotes more rational financial decision making, both on the part of the farmer and the lenders.

Finally, CCI is only one of the financial services needed by farmers to effectively manage production risk. In the absence of timely delivery of inputs or of effective marketing and price policies, CCI may have only a marginal impact on the stability on farm incomes. We conclude, based upon our Bolivian data, that the greatest utility can be realized when CCI is part of an integrated income stabilization policy which addresses the interrelated problems of yield variability, price risk, and marketing margins. In the near future, we are hopeful that this research, presently being carried out in Panama, Ecuador and Bolivia will enable us to systematically explore the interrelationships of the various elements of an integrated rural risk management program.

End Notes

[1]It should be recognized that in many cases, the credit is just not available, while in other situations small farmers are not willing to borrow.

[2]In terms of areas, potatoes account for 56 percent of the area (average of 3 years among insured and not insured farmers).

[3]Given the conditions of Bolivian highlands, the reservation wage is probably well below market wage.

[4]Some of the farmers are located far from the paved road, and at high altitude, such as in the area of Condor Puñuna, Laraty and Quewiñal.

[5]1 hectare = 2.4 acres.

[6]These farmers did not receive credit from BAB. Also insurance was not provided to farmers without BAB credit.

[7]Much resistance was shown by farmers to the new seed and the requirement for it not be produced outside the Cochabamba Valley.

[8]It includes only premium received from farmers, excluding subsidy. Fifty percent was paid by farmers and fifty percent by a government subsidy. In 1981/82 ASBA insured 97 producers in both places, Melga and Cochabamba Valley, receiving premiums for B/223 830 (from farmers); ASBA's indemnities added to B/315 828.

[9]Net income is the difference between total cost and gross income. Production costs were imputed at prices (1981) prior to a severe inflation, but income was computed at prices after inflation (1982).

[10]Also in comparison with producers using the traditional technology, the independent producers used a large amount of seed and this was of better quality, (partially reflected in a slightly larger price per 'carga' (1 carga = 105 kgs).

[11]This assumes that farmers used their own savings from the previous year, but no opportunity cost was assigned to this money. In any event, these farmers save their money under the mattress and probably not at a commercial bank. If they

borrowed from money lenders probably they paid much higher interest rates than at a commercial bank.

[12]Under the assumption that both groups use the same level of technology. It may be different if the insured groups uses improved technology.

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