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UNFORESEEN CONSEQUENCES OF INTRODUCING NEW
TECHNOLOGIES IN TRADITIONAL AGRICULTURE

Peter E. Hildebrand¹ and Edgar G. Luna T.²

Minifundios, or small subsistence or near subsistence farms, normally absorb the majority of rural people in developing Latin American and other countries. Although a great deal has been written about subsistence farms, and their inclusion in the development process is frequently considered, schemes to improve the individual economic situation of these farmers are mostly failures. Reasons for failure include various combinations of large numbers, isolation, low educational levels, lack of private resources, insufficient public resources, poorly planned or coordinated programs, and lack of information regarding economic constraints and requirements and optimum input and product combinations for feasible solutions to problems in the minifundistas.

Schultz's "Economic Efficiency Hypothesis"³ proposes that farmers in traditional, but stable agriculture have adjusted to their conditions in such a manner as to be economically efficient. We agree with this hypothesis that implies that no changes in input or product mix from among

¹Visiting Professor, Food and Resource Economics Department, University of Florida and Advisor to the Departamento de Administración Agrícola, Dirección General de Economía Agrícola and Planificación, Ministerio de Agricultura and Ganadería de El Salvador, C.A.

²Economista Agrícola, Facultad de Agronomía, Universidad de Nariño, Pasto, Colombia. Details of the study not covered in this paper can be found in: Edgar G. Luna T., Estudio de la Productividad de los Recursos Agrícolas en Zonas de Minifundio, unpublished M.S. thesis, Programa de Estudios para Graduados, Universidad Nacional - Instituto Colombiano Agropecuario (ICA), Bogotá, Colombia, Feb., 1972.

³Theodore W. Schultz, Transforming Traditional Agriculture, Yale University Press, New Haven, Conn., 1964.

the alternatives historically available will result in any significant improvement in the income to the farm.

But more and more, traditional farms are being affected by new technologies. Even though many efforts are made to supply "packages" of improved techniques, it is virtually impossible to transform the traditional subsistence farm into a "micro commercial farm" with any sort of input package. The reason is that no such package can include all the required modernizing factors in the proportions in which they are required.

It is logical to argue as Schultz has done (p. 162 ff.) that the introduction of a modern technique is not always profitable in any particular area because it may not be adapted, the price conditions may not be similar, risk may be increased, etc. Again, we do not disagree with these considerations. But we would argue that a more important effect is that the introduction of one or more new factors in an otherwise stable and traditional farm economy adversely influences the economic balance of the other traditional factors which are not being changed.

The introduction of a new variety, a high analysis fertilizer, or a potent insecticide singly, or in a package, can have such unforeseen effects as shifting labor from Stage II of production to Stage I and land from Stage II to Stage III. These shifts are so unexpected that they are seldom if ever considered when attempting to analyze the reasons for the poor performance of otherwise well planned development programs.

A study was conducted in a minifundio area of southern Colombia, near Pasto in the Department of Nariño, which sheds some light on the nature of the problem and should be of wide interest to economists and

other agriculturalists working in small farm development. In the study area, traditional agriculture remains the predominant characteristic, but through the efforts of rigorous research, extension and credit programs, many new technologies are finding their way into common use. Nevertheless, farm incomes remain low. The study which is presented in this paper discovered some of the reasons -- the unforeseen consequences -- that new technologies are not having the predicted effect on farm income.

Number of Enterprises and Farm Size

Apart from the usual classification of farms based on size, it was possible in the study to separate them into specialized and diversified farms. This was done in order to analyze one hypothesis: On small farms with few resources, diversification tends to force some resources into Stage I of production (and at the same time force others into Stage III). The implication is that any combination of enterprises would result in a lower income than specialization in only one crop at a time (owing to the concave nature of the "Opportunities Curve").

Of the 108 farms (of from 1 to 20 hectares) surveyed, it was found that from among those from 1 to 5 hectares in size, two-thirds were specialized and one-third were diversified. For the farms from 5.1 to 20 hectares the proportion was reversed. This was evidence, though not conclusive, that the farmers themselves were finding our hypothesis to be true -- on the small farms, specialization tended to yield more income. The net income figures, both per hectare and per farm, corroborated this evidence. The dividing size was 10 hectares. The average net income per hectare and per farm was greater for specialized farms of one to three, three to five, and five to ten hectares than for diversified farms.

But net income was greater for diversified than for specialized farms in the 10 to 15 and 15 to 20 hectare size groups.

The smaller (one to ten hectares) specialized farms yielded more net income than the smaller diversified farms even though the diversified farms used more traditional (labor and seed) as well as modern (fertilizer and pesticide) inputs per hectare than the specialized farms. Considering the use of modern inputs as an indicator, the small diversified farms would be rated higher than the small specialized farms -- yet their performance on a net income basis was poorer. For farms larger than ten hectares, the greater use of traditional and modern inputs on the diversified farms did produce more net income than on the larger specialized farms.

Factor Productivity and Stages of Production

In order to determine more precisely what the effects on factor productivity were, the area was studied on a crop by crop basis. Unfortunately, the survey was too small to allow the determination of factor productivity crop by crop for the specialized-diversified strata. Only the farm size classification could be used and this only for wheat, the most widely produced crop in the region.

Contrary to what one would expect, the smaller farms were not using sufficient labor in the production of wheat. Additional analysis revealed that the amount used during the growing of the crop was approximately correct, but the amount used during land preparation (which is closely tied to animal power) should be more than doubled. Although we found no indication that the average amount of labor used

for land preparation fell in Stage I, it certainly must have been close to the edge of Stage II.

The significant aspect of the insufficient use of labor in land preparation is that the farmers spend months in preparing land for seeding, and generally plow and harrow (with animals) three times each. (Plowing usually begins in October or November and seeding is in February and March.) Such a pattern probably was the most efficient given the resources available before the introduction of new varieties, the fertilizers and pesticides. But these modern technologies have all been developed in association with adequate mechanized preparation. Hence, the formerly adequate land preparation techniques now become inadequate when combined with a partial "package" of modern technology.

Apparently the productivity of the modern technology is also difficult to predict when transferred to a traditional agricultural setting. On small farms in the study area and for wheat, the quantity of seed and fertilizer used was insufficient to reach Stage II and pesticides were used in excess, the average quantity producing negative marginal productivities. On the larger farms, seed and fertilizer use was in Stage II but pesticide use still was excessive. An informed explanation of the underuse of seed on the small farms (even though the average use corresponded to current recommendations) was that the seed used by these farmers was not of the quality used for experiments or demonstrations or even by the larger farmers. Hence, the same quantity yielded less plants per hectare than anticipated in the recommendations. For both the small and large holdings, the quantity of fertilizer used was very inadequate although the use on the larger farms reached Stage II. Attempts to separate pesticides were not

entirely adequate but indications are that insecticides were used excessively while the small use of herbicides could be increased.

Area seeded was another factor of interest in the study. The results indicate that for wheat, the average area seeded on small farms (2.36 hectares) is less than the optimum size, but the 7.91 hectare average on the larger farms is too large. The implications of this effect are discussed in the conclusions.

In partial summary, it is evident that a reshuffling of the proportions of the modern and traditional factors in use on these farms could increase income substantially. An increase in fertilizer and seed use accompanied by more labor in land preparation could increase production of wheat per hectare by 50 percent and the additional costs would have a 100 percent net return.

But an overriding problem with this solution is that it is doubtful that land preparation can be markedly improved by intensifying current traditional practices. As a minimum, improved yokes for the bullocks and better implements for animal traction will have to be introduced to the area in order to achieve a more efficient balance with the other modern techniques now being used. Possibly only mechanized land preparation will suffice.

In the Department of Nariño, potatoes are an important commercial crop, but in the study area (Municipio of Yacuanquer) they rate much more as a subsistence crop (wheat is the main commercial crop). Nevertheless, potato production is high risk and requires more technology than wheat.

Labor used in land preparation was found to be adequate for potatoes but an increase in labor would be desirable during the growth of the crop. Relatively large quantities of fertilizer were used (from about U.S.

\$20.00 to \$125.00 per hectare with an average of \$65.00) but an increase would be profitable. Pesticide use, while very common, was found to be quite inadequate (average insecticide use did not reach Stage II).

Corn, another subsistence crop in the area, is considered inferior to potatoes and grown usually in small plots. In accordance with its stature in importance, it receives relatively poor care and few modern inputs. Indeed, our study indicated that labor, seed, fertilizer and pesticides were all used in quantities too small to reach Stage II of production. Under the circumstances the farmers would certainly have been better off not raising corn except that they did so as a form of insurance for home consumption.

Conclusions

This study, which was undertaken in a traditional agricultural area being subjected to modern technologies through rigorous research, extension and credit programs, demonstrates that serious maladjustments have been created in resource combinations such that some factors of production are in Stage I and others are in Stage III. It is very likely that this maladjustment affects all traditional economies which are subjected to incomplete "packages" of modern or new techniques. But it is also very likely that it is not possible to supply complete packages because too many factors would have to be included. One extremely important factor which is virtually impossible to include in a package (except on a very small scale) is the management capability of the small farmer.

The conclusion that must be reached is that maladjustments will always exist so long as traditional (or even non-traditional but poorly developed) agriculture is subjected to the development process.

The same conclusion holds, of course, for any economy which is not static. The difference is that in a more developed economy the changes are expected, can be predicted, and are relatively short-run -- adjustment begins as soon as the maladjustment is felt. In a traditional economy, people may well be better off than before even if their resource combination is inefficient so there is no feeling of being out of adjustment. Further, a traditional agricultural economy is seldom studied in this light; so, rarely is it determined that the factors of production are inefficiently allocated. In fact, there has never been any real development of a "Theory of Subsistence Economics" to serve as a basis for such studies.

It can also be concluded that there is a tendency toward lesser incomes on small farms which are diversified than on those which are specialized. We were unable to demonstrate in the study that this was due to a concave opportunities curve resulting from combining enterprises in Stage I of production. However, there is substantial evidence that this is indeed what happens because many factors, even on specialized farms were shown to be in Stage I in this traditional economy which is being subjected to the modernizing process.

To be specialized does not mean that a farm can produce only one crop a year such as wheat in our study area. Nor does it mean only one crop each semester (either the same or a different crop). A few different, but similar vegetables, for instance, could probably be raised by one farmer "specialized" in vegetables without his being affected by uneconomic enterprise combinations. But to combine the vegetables with corn or wheat or even potatoes probably would mean to feel the effect of the concave opportunities curve.

Another conclusion of the study is that specialization of small farms can tend to reduce the pressure for expanding farm size in areas where population is high and land scarce. It is easier to reach the optimum area planted for one crop on a small farm than for each of two or more crops. Thus, specialization can be an important component of an agrarian reform program.

Recommendations

One of our recommendations deals with action programs and the other deals with research as a source of information for the action program.

Any action program oriented toward the development of small, traditional farms in any particular area, must consider the desirability of developing specialized farms rather than diversified farms. Even though specialized farming bears a higher risk to the producer, small farmers in our study area tended toward it. But it must be recognized that the risk factor is extremely important. When a farmer puts all his resources into the production of one crop he must be assured that a reasonable market exists for his product and that he can purchase his other necessities at reasonable prices when he needs them. This requires a well developed infrastructure (which was the case in our study area) and a degree of confidence in the stability of the economic system, at least in the short run. Without these assurances, it will be difficult to convince a traditionally self-sufficient farmer to specialize in the production of a single crop to increase his real income.

Accompanying any successful development program must be a carefully planned and critical research program. Besides the normal research into varieties, pesticides, fertilizers, crop combinations and other practices,

the complete research program must include continuing studies of the nature of this study to ascertain the current status of the development process and help guide the rational introduction of new technologies into traditional agriculture.