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AGRICULTURAL CHANGE AND SOCIAL STRUCTURE: A LONGITUDINAL ANALYSIS

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The social and economic changes associated with the development and spread of high-yielding cereal varieties in the late 1960s present a formidable challenge for sociological analysis. Propositions asserting the primacy of technology and economic policy as moving forces in social change would appear to be the principal hypotheses for analyzing the social consequences of the new seed-fertilizer practices. This paper reports on research which examined the relationship of technological change in agriculture and institutional change in barrios. It uses models derived from technological and economic policy approaches as well as from sociological work on macro-structural analysis. If a sociological interpretation can be sustained through competitive model testing, the implications for both policy and technology assessment may be considerable.

Alternative Approaches

Three approaches, positing different independent and dependent variables, will be utilized. Each approach represents a different conceptualization of the relative roles of green-revolution technology and social structure. The *Technology and Output* approach suggests that change in institutional structure is a result of the presence of technology.

Technology ⟶ Change in Social Structure
time 2 time 2 - time 1

The *Policy and Economic Access* approach also accepts technology as an independent variable, but qualifies its role. Because the new seeds require a variety of inputs to maximize production and hence economic returns, availability of and access to inputs is a critical factor in determining the spread and use of the new technology and consequently the technology's impact.

Access to Market
Technology ⟶ Change in Social Structure
time 2 time 2 - time 1

The *Structure and Organization* approach subordinates the role of technology and policy to an emphasis on organizational structure. Analytical focus is on the interrelationship of ongoing organizational processes.

Structural Change ⟶ Structural Change
↘ technology ↗

Technology and output

The principal framework for analysis of the green revolution places emphasis on the predominant role of technology in facilitating major improvement in agriculture productivity.

> (T)he key element is the developed science of the world. . . Farmers themselves only make small marginal and incremental changes. The big inputs will come from research centers and scientists (Nash 1969:54).

Although a role for economic policy and social structure is acknowledged, it is a dependent role with technology considered the independent variable. The prevalent analytical style is thus assessment of the impact of technology. For example, in 1968, Lester Brown, a major advocate of the green revolution's promise, wrote:

> The exciting new cereal varieties are so superior to the traditional varieties and so dramatic in their impact

that they are becoming engines of change wherever used (Brown 1968:694).

Two years later, Brown continued in the same vein:

The technological breakthrough achieved by agricultural scientists foreshadows widespread changes in the economic, social, and political orders of the poor countries (Brown 1970:6).

Policy and economic access

From the perspective of this framework, the principal characteristic of the new technology is that it is the first application of science to agriculture in less-developed countries that can be manifested "as divisible inputs available to individual cultivators" (Frankel 1971:2). However,

Peasant farmers may all be "economic men," but not all of them may get the chance to prove it, at least in the near future (Blair 1971:356).

Thus the role of policy is to facilitate access and with it, the exercise of rational economic decision making. "Giving all farmers access is essentially a problem of 'institutional development' (Owens and Shaw 1972:72)," but institutions of a particular genre.

The institutional package provides the economic environment needed to implement the production package, and it forces the farmer one step further into the market economy (Fisher 1972: 23).

Structure and organization

Carl Gotsch illustrates the tentative perspective on the relationship between structure and technology that characterizes this approach. He points out that it is only recently that research has started to look intensively at the ways in which technology and institutions interact over time. He argues, for example, that:

prognoses about the distributive effects of agricultural technology are of little help unless the characteristics of the technology are related to the social and political institutions of the countryside (Gotsch 1972: 327).

The structure and organization approach proposed by Frank Young (1970) concentrates on the interrelationships of structural variables. It is a model which emphasizes interorganizational as well as intra-organizational relationships. The model is built around three variables. *Differentiation* refers to the diversity of meaning structures maintained by a group. *Centrality* refers to the extent of a subsystem's participation or inclusion in a larger system. *Solidarity* is an indication of "the degree to which the social systems maintained by a group are organized to convey a focused definition of the situation" (Young 1970: 298).

Young has interrelated these three variables in the form of a hypothesis about the emergence of organizational solidarity. He argues that where differentiation changes at a faster rate or is at a higher level than centrality, subsystem solidarity is more likely.

(V) Change in Differentiation
Change in Centrality ⟶ Solidarity

Model V presents a format for an ongoing process that may be important in understanding the role of green-revolution technology. For example, there may be a relationship between organizational mobilization and macro-adoption of green-revolution technology. Such a relationship could be defended theoretically by pointing to the type of group processes which may underlie individual acts of innovation and entrepreneurship.

(VIa) Change in Differentiation
Change in Centrality ⟶ Solidarity

(VIb) Solidarity ⟶ Technology

Model VIa-VIb could be modified to focus on the role of the public policy.

(VIc) Change in Centrality
Solidarity ⟶ Public Policy

(VId) Public Policy ⟶ Technology

In this modified version, public policy is treated as an intervening variable between ongoing structural processes and individual acts of technology adoption.

Toward Comparative Analysis

Since a fundamental issue in evaluating the three approaches is the status of change in social structure in relation to technology, a basic dimension of social structure needs to be referenced by all three approaches. Moreover, to facilitate comparative inquiry, a common definition for this dimension satisfactory to all three approaches needs to be developed. The structure and organization approach has focused on structural differentiation, a concept that can be interpreted as the group level correlate of the increasing specialization concept which predominates within the technology and economic access frameworks. However, by raising the level of abstraction and conceptualizing differentiation as the diversity of meaning structure maintained by a group, the structure and organization definition is sufficiently general to subsume the theoretical claims made by the other two approaches regarding the salient features of social structure. Thus, change in social structure will be defined in terms of change in structural differentiation.

Research Setting

Iloilo Province presents a good example of a setting for the green revolution. Already a major rice producer in 1960, production almost tripled by 1970 while the amount of land planted to rice increased by 82 percent.[1]

A region was identified within Iloilo Province. It consists of 10 municipalities with 338 barrios and population of approximately 215,000 in 1970. It covers an area of about 132,000 hectares. Crossed by 60 streams and two major rivers, the region is a lowland plain that becomes rolling going north and east.

Although Iloilo City, with a population of over 200,000 is physically close to the region, its influence is limited. Once the premier city of central Philippines, it has undergone an absolute decline since 1945. The status of Iloilo City is appropriate for the analysis because it facilitates examination of relationships between technology and village structure with reasonable control on the external influence of a major urban center. In effect, with Iloilo City declining, the region is in the process of developing a new internal structure with which to relate to the outside.

In defining the region, it should be added that none of the municipal systems are primarily linked to Iloilo City but rather all the municipal systems are linked mainly to each other. The lowland rice area in the region is the major rice production area for the province. Covered by extensive irrigation facilities in the late 1950s and early 1960s, it has also been the focus of continual public policy-making in agriculture, particularly community development, price support, credit, and subsidized input supply. During the late 1960s the region was one of 15 priority areas chosen for participation in a major crash program to increase rice production through the spread of high-yielding seeds.

Since many types of inputs were first introduced into the region in 1961-1962, the analysis will use 1960 as a benchmark date and 1970 as a point for assessing the impact of the technology package.

Variable Operationalization[2]

Differentiation

A Guttman scale of barrio structural differentiation was constructed for 1960 and 1970. The scale score is the value of differentiation level variable; the difference in scale scores for each barrio is the value of the differentiation *change* variable.

The dimension assumed to underlie the scales is the emergence of separate institutional sectors. Step one indicates a nascent differentiation. It is operationalized by the presence of a *sari-sari* store. This is a minimal form of sectoral differentiation; an encapsulation of several potential institutional sectors most of which are not directly related to agricultural production.

Step two is a sector characterized by the processing of local agricultural production for on-farm consumption. This excludes the large rice mills which are indicators of differentiation at the municipal level. Instead, it is measured by the presence of small *kiskisan* mills. Meat slaughter and fish preservation are similar on-demand operations that service output not destined to reach the market economy. On the whole, this step references a logical early direction for sectoral differentiation within agriculture by pointing to the appearance of simple processing capabilities.

Step three is a non-crop production activity on a commercial scale. This is measured by the presence of an organized economic activity that provides meat or fowl on a regular or continuing basis.

Steps two and three represent elaborations derived from the basic crop production activity. Step two processes the output, step three uses it. Step four is an elaboration of step one. It indicates the further emergence of institutional sectors not directly related to agricultural production. Step four is measured by the presence of typically home-based activities which produce goods that each family formerly produced for itself. Examples are: a tailor, a bakery, and an earthenware producer.

Step five implies a more specialized level of basic service provision. However, the services are still on demand and adaptable to particular specifications. Local metal fabrication, for example, can range from agricultural implements manufacture and repair to provision of various house construction materials.

Step six is the development of specialized economic activity that is characterized by standardization of output. This step suggests that differentiated sectoral development in agricultural and non-agricultural activities is supporting the institutionalization of a specialized but continuing demand for particular goods and services.

Step seven implies that institutional differentiation has proceeded to the point where systematic self-tracking and adjudication is necessary on a regular basis. The presence of accounting or legal firms serving only the barrio in which they are located indicates a level of complexity that requires frequent monitoring and intervention to ensure orderly activity.

An argument might be made for threshold levels within the differentiation dimension, but the argument would be complicated by the large increase in scale errors from 1960 to 1970. Major efforts in the encouragement of cottage industry development, especially by the Agricultural Productivity Commission, the Presidential Assistant on Community Development and the National Cottage Industry Development Authority helped move several barrios directly into step three which previously were in step one.

The operationalization of differentiation is consistent with the focus on service specialization characteristics of the technology and economic access approaches. However, the dimension underlying the scale is institutional differentiation for the barrio social system, not economic specialization alone. The assumption is that systemic rather than intra-sectoral structural complexity is being tapped by the scale and that this complexity has a broader symbolic content.

Technology

The major independent variable, technology, is operationalized by a 0, 1 dummy variable. If more than one-half the cultivated land in a barrio was planted to high-yielding seed varieties,[3] the barrio was considered to be in the technology class. In 1970, 68 barrios or 20 percent of the 338 barrios in the region were in the technology class. Operationalizing technology in this manner facilitates testing whether presence in the technology class is associated with systematic differences in variable interrelationships compared to barrios not in the class – especially with regard to structural differentiation.

This is admittedly a crude operationalization and it does not, for example, facilitate an assessment based on the degree to which a range of associated practices are being employed. On the other hand, the claims have been for the seeds and their use and only secondarily for nuances in utilization.

Access: distance

Access is operationalized by the typical central place indicator: Distance from the market center. In this instance distance was measured in meters using aerial photographs from the barrio fringe to the fringe of the municipal center by the most direct route actually utilized. The values ranged from zero to 17 kilometers. A common logarithmic transformation is used to correct for left skewness.

Population

Population size was measured for 1960 and 1970. The overall growth rate in the region was 13.2 percent for the ten-year period, or an annual growth rate of 1.3 percent. This is well below the estimated national annual growth rate during the same period of approximately 3 percent.

Closer examination of the population data reveals that the pattern of aggregate change is somewhat misleading. There were 250 barrios which grew at an annual rate of 2.4 percent, much closer to the national average. However, 88 barrios *lost* population at an annual rate of 2.5 percent. Part of this is undoubtedly an artifact of uneven census coverage. But the evidence is still strong that not all barrios are growing. The interrelationship of this pattern of growth and decline to adoption of green revolution technology is, of course, the focus of this analysis.

Public policy: water

Water policy has taken several forms but primary emphasis has been on pump distribution and gravity system construction. The major effect in gravity irrigation construction has been the establishment of an 11,000 hectare system covering one portion of the research region. Pump distribution became especially important in the late 1960s in the context of the Rice and Corn Production Coordinating Council crash program. Because the analytical emphasis is on the distribution of probabilities that barrios having access to irrigation water would have systematically different relationships among other variables, a 0, 1 dichotomous variable is used. For the period 1960-1970, 42 barrios were covered by some form of public water policy.

Public policy: soil

Soil testing may be the one acceptable surrogate variable for the green revolution technology other than the seeds themselves. Soil testing is intimately linked to optimal fertilizer application and fertilizer application is the major chemical complement to the seeds. Public soil policy consists of soil tests performed as a part of some area program. Beginning in the early 1960s, several programs were implemented in the research region under sponsorship of a United Nations Development Program Special Fund project and the Rice and Corn Production Coordinating Council. Since the tests are multi-barrio targeted and are not unlimited, analytical interest goes beyond measurement of whether a barrio was included. Instead, interest extends to the probability that a barrio received the maximum amount of the policy. This controls for those situations where some barrios receive coverage because of proximity to barrios that were the intended targets. Thus the variable is measured by:

$$PS = \sqrt{B_{i_{\Delta t}} / R_{\Delta t}}$$

where $B_{i_{\Delta t}}$ is the number of soil tests performed in a barrio in the 1960-1970 interval.

$R_{\Delta t}$ is the maximum number of soil tests performed in a barrio anywhere in the region in the 1960-1970 interval. During the 1960-1970 interval, 90 barrios were covered by soil testing. There were 557 tests made with 83 being the highest number given to any single barrio.

Regional control: lowland

Lowland refers to those barrios where all the land area is level according to topographic maps and aerial photographs. This is typically the best land for rice production. The variable is operationalized as a 0, 1 dummy variable. There are 66 barrios in this class.

Table 1

Guttman scale of barrio structure differentiation (Iloilo Province, 1960 and 1970)

Scale Step	1960			1970		
	N[a]	P[b]	E[c]	N[a]	P[b]	E[c]
1. *Elementary diversification* sari-sari store	338	100	0	338	100	0
2. *Processing of local production for local consumption* kiskisan mill, meat slaughter, fish preservation	192	57	4	201	60	11
3. *Secondary agricultural production* piggery, poultry	43	13	9	69	20	15
4. *Local services: basic consumption* tailor, shoe repair, bakery, earthenware	19	6	6	26	8	12
5. *Local services: infrastructure* manufactured metal products, fabricated metal, motor vehicle repair and rebuilding	13	4	4	14	4	6
6. *Local services: specialized and standardized* pharmacy, feed and fertilizer sale, appliances, sales, lumber sales, motorscooter shop	7	2	6	9	3	6

Table I (continued)

Scale Step	1960			1970		
	N[a]	p[b]	E[c]	N[a]	p[b]	E[c]
7. *Institutional arbitration*						
legal firm accounting	3	1	0	4	1	0
TOTAL ERRORS			22			50
Coefficient of Reproducibility			.98			.98
Goodenough Coefficient of Scalability			.87			.82
Z Score (from Green's I)			12.84[d]			12.63[d]

[a]Number of barrios discriminated.
[b]Proportion of population discriminated.
[c]Errors.
[d]Significant at .005 level.

Use of a regional control serves two purposes. First, it identifies the subgroup of barrios that topographically are best suited for rice production. Second, it pinpoints systematic differences in variable interrelationships between barrios which have been in rice production the longest, where patterns of land ownership are more rigid, productivity is highest, and the structure of tenancy is most complex, and barrios with more heterogeneous histories.

Centrality

A Guttman scale of barrio centrality was constructed for 1960 and 1970. The scale score is the value of the centrality *level* variable. The difference in scale scores for each barrio is the value of the centrality *change* variable. The theoretical dimension assumed to underlie the scale is more encompassing recognition of a barrio within an interbarrio system. Since recognition is in reference to a subsystem's social identity within some larger system, increases in the range of recognition and shifts in the source become important indices of symbolic inclusion.

Thus barrio centrality is measured in relation to a hierarchy of system types. The primary reference is the most proximate spatial system, the municipal intervillage system. But beyond that, there is the region, the Congressional District, the Province, and the nation itself. Barrio-specific recognition from any of these extra-municipal sources implicates the barrio in a new and not necessarily spatially contiguous network. *Poblaciones,* for instance, can be defined in terms of their municipal intervillage systems, but they can also be defined in terms of a regional interpoblacion system.

Step one of the scale indicates that a community has the minimal recognition consistent with membership in any intervillage system: acknowledgement as an identifiable entity. In most cases this acknowledgement comes from within the municipal system, but in a few cases, barrios physically present did not have recognition at the municipal level. However, if a community was referenced as a barrio in the *Official Gazette,* in any public document,[4] or in Congress,[5] the community was considered recognized.

Step two refers to barrio centrality with reference specifically to the municipal intervillage system. Since a defining characteristic of

Table 2

Guttman scale of barrio centrality (Iloilo Province, 1960 and 1970)

Scale Step	1960			1970		
	N[a]	P[b]	E[c]	N[a]	P[b]	E[c]
1. *General inclusion* Recognition as a barrio	338	100	0	338	100	0
2. *General linkage* Any type of direct road from the barrio to the poblacion; A railroad line passes through the barrio	217	64	12	243	72	15
3. *Particularistic recognition* Gas station; Railroad siding or flagstop; Presence of a coconut farm of at least 20 hectares	64	19	15	74	22	19
4. *Limited recognition* Temporary or intermittent presence of an extension agent; Presidential visit	15	4	6	14	4	5
5. *Continuing recognition* Secondary school; Health center; Puericulture center; Administrative status	11	3	5	12	4	1
TOTAL ERROR			34			40
Coefficient of Reproducibility			.98			.98
Goodenough Coefficient of Scalability			.84			.82
Z Score (from Green's I)			9.04[d]			8.03[d]

[a]Number of barrios discriminated.

[b]Proportion of population discriminated.

[c]Errors.

[d]Significant at .005 level.

municipal intervillage networks is spatial contiguity, accessibility and physical linkage are indications of degree of participation. The step is measured by the presence of any usable man-made connection to the poblacion.

Step three indicates the presence of particularistic recognition from levels between the municipality and the nation. The recognition is particularistic in the sense that it does not have multifunctional connotations, although it may be continuous over time. For example, the presence of a gasoline station represents a point of tangency between particular aspects of barrio structure and particular aspects of regional or provincial structure.

Step four refers to recognition that is more generalized but less durable. This type of recognition can emanate from any extra-municipal source. For example, a visit by the President of the Philippines is an explicitly diffuse form of symbolic inclusion, but one that is temporally very limited.

Step five marks the appearance of a type of recognition that is both broad in scope and continuous over time. Because barrios at this step are at strategic nodes in higher level intervillage systems, they are able to *give* valued recognition. In a system of nested hierarchies, these barrios are the symbolic gatekeepers and thus playing representative functions within several intervillage systems. The poblacion is an example. As the administrative center of the municipality, it has designated centrality within that network and a representative function in extramunicipal networks.

Examining Table 2, it can be seen that movement across steps two and three is marked. The error pattern for steps two and three especially suggests that recognition by different system types has not proceeded in an orderly sequence. This is not surprising since in an administratively centralized system like the Philippines, the sequence of vertical articulation may vary considerably. Thus the scale steps can be interpreted as a theoretically "average" sequence. The scale is admittedly short, but this reflects the limited types of recognition available. More complex systems might demonstrate more subtle variants, presumably filling in steps between those already in the scale.

Dual membership

There is one variant of centrality that is available and one that can also be interpreted from the perspective of central place theory and the economic access approach. If a barrio has a direct physical link to the poblacion of another municipality but does *not* have a direct link to the poblacion of its own municipality, it is considered to be a member of the dual membership class. Therefore, these will be barrios that scored zero on the second step of the centrality scale but would have scored one if they were referenced to another municipality. In 1960, 24 barrios had this characteristic. By 1970, the number rose to 42. This subgroup is of special interest because it represents instances of conflicting subsystem definitions. Within that context, dual membership barrios potentially have the flexibility associated with marginality. A related point from the economic access perspective is that these barrios may be considered as candidate emerging competitive market centers.

Solidarity

Theoretically, the thrust of the solidarity variable in the structure and organization model is to identify a class of barrios. Thus, for example: Model (V) focuses on the conditional probabilities that variables with certain levels of change in differentiation and centrality will be solidarity barrios. That leads to a second point which is that analytical interest will be in ascertaining the probabilities associated with being in the solidarity class.

Both points suggest operationalization by a dummy variable. While some structural solidarity may be present as a basic characteristic of any group, analytical discrimination requires an emphasis on the more intense forms of internal focusing. If there were indicators of more intense solidarity in the interval period 1960-1970, the variable equals one. The pool of items can be grouped into three types.

1. There is evidence of an organized attempt

to gain some form of outside acknowledgement or recognition of some change in current identity. Examples: There is an inter-barrio dispute; the barrio petitions for a name change or some other type of revised recognition.

2. There is evidence of internal focus which is exclusive, that is, it sets the barrio off from other barrios. Examples: There is an unregistered cooperative (these are small barrio-based organizations that compete with the nationally supported municipal Farmers Marketing Cooperatives); there is a non-Catholic church present that is supported primarily by the barrio rather than outside sources.

3. There is evidence of internal focus which threatens to be inclusive, that is, it potentially implicates other barrios and could be generalized to extra-municipal intervillage networks. Examples: Agricultural strikes; organized violence.

During the period 1960-1970, 74 barrios or almost 22 percent of the total barrios in the region had manifestations of solidarity.

Comparative Model Estimation

Relationship (1) represents an estimation of the simple technology and output model. Since technology is operationalized as a dummy variable and the specification of the regression does not include articulation of a precise functional form, the application of regression amounts to the estimation of cell means.

The mean value for ΔD in the whole population is .13. Relationship (1) indicates that the mean value for ΔD in the technology class is .19; outside the technology class it is .12. The basic technology and output model is supported although the differences between classes are not as strong as advocates of the approach have intimated. Nevertheless, the basic direction of the relationship is consistent with the technology and output hypothesis.

The next step is to explore possible alternative explanations and at the same time indicate the elaborative roles of other variables. Relationship (2) presents estimation results for a simple policy and economic access model.

Table 3

Relationship 1: regression of technology on change in differentiation

Relationship 1

Dependent Variable: Change in Differentiation (ΔD)

Independent Variable	Regression Coefficient	Coefficient Standard Error
Technology (T)	.07	.06
Intercept	.12*	.03

**t* value significant at .10 level

Table 4

Relationship 2: regressions of lowland, technology, and distance on change in differentiation

Relationship 2

Dependent Variable: Change in Differentiation (ΔD)

Independent Variable	Regression Coefficient	Coefficient Standard Error
Lowland (L)	.07	.07
Technology (T)	.02	.07
Distance (d)	–.06*	.03
Intercept	.33*	.11

**t* value significant at .10 level

With the addition of a lowland regional control (L) and distance from the *poblacion* (d), the role of presence in the technology class is obscured. The mean value for ΔD in the technology class, controlling for lowland regionalization and distance from the *poblacion* is not sufficiently different from the mean for barrios not in the technology class. Instead the critical factor in explaining the distribution of differentiation change scores is distance from the municipal center. The negative sign on the distance parameter suggests that relative lack of access is a constraint on positive change in differentiation. A portion of the economic access argument is, therefore, supported. But the sharply reduced role of technology is difficult to interpret. If access is critical, and its reference is to some type of linkage what can that linkage be if technology is not important?

Table 5

Relationship 3

Dependent Variable: Change in Differentiation (ΔD)

Independent Variable	Regression Coefficient	Coefficient Standard Error
Lowland (L)	.08	.07
Technology (T)	.53*	.23
Distance (d)	−.11*	.04
Technology – Distance Interaction (Txd)	.16*	.07
Intercept	.49*	.13

*t value significant at .10 level

Relationship (3) tries to answer this question by looking at the possibility of interaction between presence in the technology class and distance from the market center. Figure 1 displays graphically relationship (3).

Within approximately 2,000 meters of the poblacion, barrios *without* technology have higher mean change in differentiation than barrios with technology. Beyond 2,000 meters the relationship reverses. If a barrio is in the technology class, the likelihood is that its mean differentiation change will increase as distance from the market center increases. If it is not in the technology class, then increasing distance will be associated with decreasing distance with decreasing mean change in differentiation.

Relationship (3) brings the technology and output and policy and economic access models into conflict with each other. The interactive term supports technology and output hypotheses, but undermines economic access expectations about the role of distance. The additive terms support policy and economic access hypotheses about the role of distance, but undermine technology and output expectations about the role of presence in the technology class.

Two points thus emerge. The first is the necessity to clarify the role of access to the market center. Policy and economic access expectations about the role of distance supported in relationship (2) are contravened in relationship (3) for those barrios in the technology class, but supported for those barrios not in that class. The second point is the necessity to identify what other factors might be accounting for change in differentiation. The high levels of mean change in differentiation among barrios close to the *poblacion* but not in the technology class suggests that change in differentiation may be responding to variables other than technology.

One possibility that relates to both points is to explore the possible role of change in aggregate demand as represented by change in population. Another possibility is to assess the role of potential competing centers within the municipal intervillage systems. One place to look for such centers is in the dual membership class. Physically linked to the center of an adjacent municipality, dual membership barrios are potentially enclaves of rapid change, constrained less by either intervillage system.

Another clarifying possibility is the role of public water and soil policy. Their distribution may shed light on the relationship between technology and distance by filling in another aspect of the access dimension. Relationship (4) presents a fuller policy and economic access model by including the probabilities that a barrio received soil (PS) and water (PW) policy and that a barrio was a member of the dual membership class (dm).

The basic form of relationship (3) is again maintained with the point of intersection

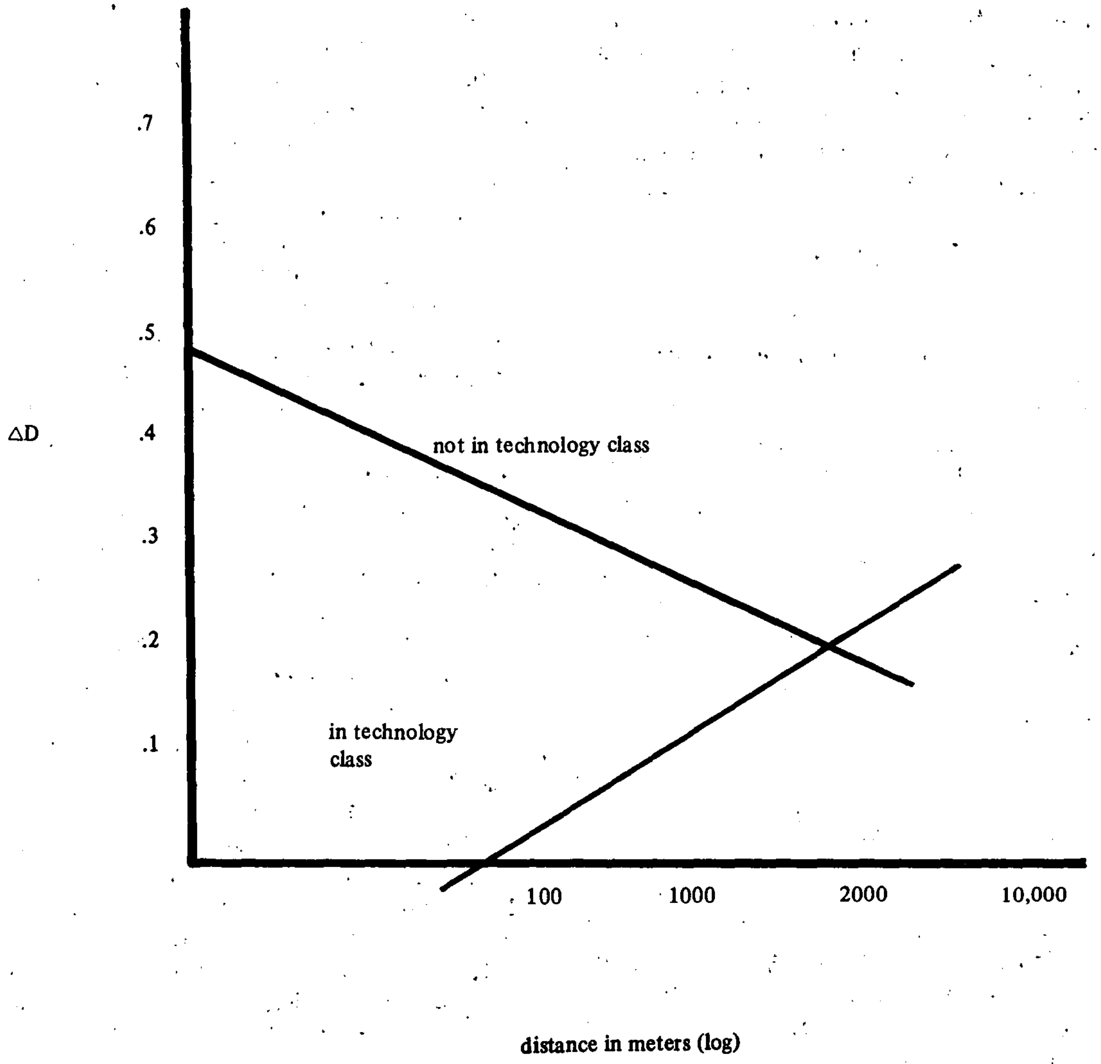

Figure 1
Relationship between mean change in differentiation and technology and distance controlling for lowland.

Table 6

Relationship 4
Dependent Variable: Change in Differentiation (ΔD)

Independent Variable	Regression Coefficient	Coefficient Standard Error
Lowland (L)	.02	.07
Technology (T)	−.41*	.23
Distance (d)	−.10*	.04
Technology – Distance Interaction (Txd)	.14*	.07
Population change (ΔP)	.02*	.007
Dual Membership (dm)	−.11*	.07
Public policy: soil (PS)	−.10	.12
Public policy: water (PW)	−.17*	.15
Intercept	.47*	.13

**t* value significant at .10 level

between the technology and non-technology class at approximately 1,000 meters from the *poblacion* fringe. However, the signs of the parameters of the three new variables are all contrary to expectations. Dual membership strongly discriminates, but the negative sign does not support the hypothesis that members of this class are emerging competing centers. If anything, it upholds the original policy and economic access argument and lack of access as indicated by distance are critical factors.

However, the significance of that support for the original distance hypothesis is muddled by the negative parameters for the two policy variables. The probability of having water policy and the probability of having been covered by the maximum share of soil policy are *inversely* related to change in differentiation. Given the essential role of water availability and chemical inputs in the green revolution package and given dependence on public policy for provision of these factors, the negative signs for both policy variables must be considered a disturbing result for both the technology and economic access approaches. In light of the persistence of the relationship (3) functional form and despite the shifting points of intersection between technology and distance and the roles of other economic factors in accounting for change in differentiation remain.

One possible explanation for the ambiguities encountered thus far is that this is a case of technological change that is still incomplete. It might be argued, for example, that big and "progressive" farmers have already adopted the new technology. The currently observed distributive gaps would thus represent failure to adopt by presumably less progressive and perhaps smaller farmers. In this context, survival of the laggards is an interim question — settled eventually on an aggregate basis in relation to achievement of self-sufficiency, availability of foreign exchange and comparative production costs. Stated more simply, the argument is that the traditional diffusion S curve has not yet peaked.

Although it may be true that the S curve has not peaked, this does not preclude the possibility that the whole adoption process is occurring in the context of other group processes. The question is one of specifying the significance of other group processes for a particular type of group behavior: facilitation of individual adoption of technology.

Secondly, as a unirelational model, relationship (4) is unsatisfactory. In addition to not clarifying the ambiguities previously encountered, it is likely that relationship (4) contains *several* relationships. In terms of the logic of comparative testing, we have proceeded so far on the assumption that change in differentiation is a dependent variable, an effect of the shape of the diffusion curve. However, from the perspective of the structure and organization approach, that decision may itself be a misspecification. For example, even simple relationship (1) does not consider the possibility that it is differentiation which may be the independent variable. Relationship (4) does not consider the role which differentiation may play in the distribution of public policy nor the role other structural variables may play in facilitating technology adoption. In light of these and similar considerations, it may follow that the interaction between technology and distance may be an artifact of misspecification.

There is also a need to clarify the possible relationship between the organizational mobilization connected with technology adoption and the organizational mobilization covered conceptually by solidarity. One possible link is that the organizational focusing associated with

Table 7

Relationships 5-10

Dependent Variables

Independent Variables	5 Public Policy Soil	6 Public Policy Water	7 Technology	8 Centrality 1970	9 Solidarity	10 Differentiation 1970
Public policy: soil	Y		1.34*(.81)		.59 (1.55)	– .62 (5.6)
Public policy: water		Y	.78 (1.1)		–1.55 (1.53)	1.4 (2.1)
Technology			Y			.10 (.24)
Centrality 1970	.02*(.01)	.02*(.01)		Y	.007 (.07)	.03 (.09)
Solidarity	–.05 (.12)	–.12 (.11)	.44*(.25)	.08 (.40)	Y	
Differentiation 1970				.04 (.03)	.07*(.04)	Y
Lowland		–.01 (.02)	.62*(.06)			
Distance			.04 (.04)	–.08*(.04)	– .05 (.06)	
Dual membership				.05 (.07)		
Population 1970				.004(.005)		.02 (.05)
Centrality 1960				.004 (.005)		.02 (.05)
Differentiation				.81* (.03)		.95* (.07)
Intercept	.03 (.03)	.06*(.03)	– .26*(.23)	.61*(.17)	.30 (.30)	–.05 (.10)

**t* value significant at .10 level

technology adoption may be induced by policy, particularly water policy. In the context of this discussion it would mean that policies may have an independent role in changing the parameters of basic structural dimensions.

In order to continue with the effort to clarify the role of ongoing structural processes in relation to the adoption of green revolution technology, the focus is altered from *change* in structural variables to *levels* of structural variables. Using levels rather than change rates should be a more direct test of technology and output expectations because it relates explicitly to the role of the existing social infrastructure. While one technology and output hypothesis is that technology utilization will change structural variables, a more basic assumption is that technology utilization is not dependent of levels of structural variables. Using levels rather than change rates of structural variables should be more amenable also to the static relationships of the policy and economic access model. Here again the assumption behind the hypothesized independent role of policy in relation to structural change is that policy itself is not dependent on levels of structural variables.

Relationships (5)-(10) present the results for the estimation of a model based on levels of structural variables.[6] Figure 2 presents a visual display of the statistically significant parameters in relationships (5)-(10).

Barrios in the technology class are strongly associated with three variables: solidarity, public soil policy, and lowland regionalization. The sign for public water policy is also positive, but the parameter is weak. Relationships (5) and (6) indicate that public water and public soil policy are inversely related to solidarity when centrality level is controlled. Rather it is that centrality level which is the strongest independent variable for both policies.

Thus, barrios in the technology class in 1970 are barrios which were at higher centrality levels in 1960. Centrality level in 1960 is an antecedent variable; both public policies are intervening variables. In relationship (9), where the roles of differentiation and centrality levels in 1970 are controlled, the resultant role of public soil policy in yielding high conditional probabilities of being in the solidarity class is weak; for public water policy it is negative. Thus the hypothesized independent role of policy on structural variables is not supported. Public policy is itself dependent on higher levels of 1960 centrality.

Barrios in the technology class are very likely to be barrios in the solidarity class. And presence in the solidarity class is most strongly related to the differentiation level for 1970. Finally, differentiation in 1970 is predicted best by differentiation in 1960. The roles of public policy, technology, population and centrality in 1970 are all marginal.

Conclusion

Green-revolution technology has as its principal characteristic its divisibility. The results reported here suggest that the acts of individual resource organization required by that technology are most likely to be found where there is some form of organizational mobilization and internal focus by the larger group itself. Those who pointed to the technology's divisibility as a major attribute were correct. But what they missed is the possibility that the divisibility would *reinforce* the direction of the relationship between structural processes and technology adoption.

Similarly, access is a key, but not access simply to economic infrastructure. Rather, it is access to a place in an inter-organizational network that is consistent with intraorganizational complexity. One implication is that the generation of externalities, which is the premise of the presumed social consequences of the green revolution technology, may be less significant than the pattern of symbolic interdependencies apparent in the macrostructural analysis reported here.

Agenda for public investment based on lists of missing and "necessary" components for adoption and utilization of green revolution technology should still be developed – but with full recognition of the role of ongoing organizational processes. At the least, analysis of that sort may indicate more clearly the relationships between alternative organizational strategies for

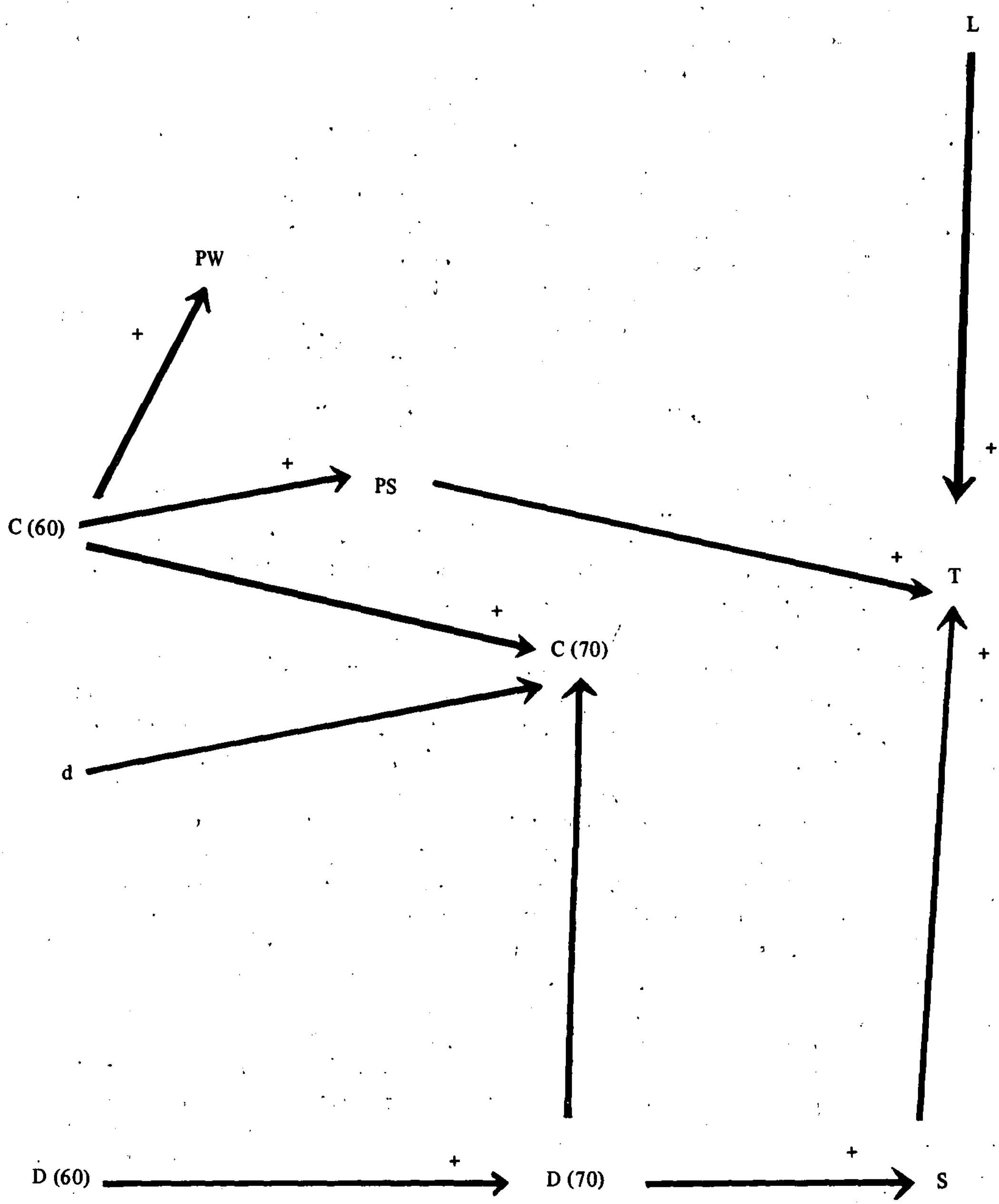

Figure 2

Display of Relationship (5) – (10)

local-level and regional-level technology diffusion and utilization and distribution of the benefits from the technology.

Notes

At the time he submitted this paper, Bruce Koppel was a research associate at the Technology and Development Institute, the East-West Center. The research reported in this paper was conducted from 1969-1971 while Dr. Koppel was a participant in the University of the Philippines College of Agriculture-Cornell University Graduate Education Program. Dr. Koppel was affiliated with Central Philippine University during the major portion of research in Iloilo. An earlier product of that research was "Society, Policy, and Technology: An Analysis of Agricultural Change in the Western Philippines 1950-1970" (Ph.D. dissertation, Cornell University, 1973).

1. New land includes double-cropping of land formerly single cropped.

2. There are considerable problems associated with data availability at the barrio level for structural analysis. Published secondary data sources have limited usefulness. Except for basic demographic materials, data are aggregated to municipal and provincial levels. Thus, the initial data collection strategy was to recover pre-aggregated data. Other sources were also used; for example, aerial photos and topographic maps for 1948-52, 1960, and 1966-1970 were compared and evaluated; all issues of the Iloilo Times from 1948 to 1971 were read and coded; records of major regional institutions were examined and key informants interviewed; key informants from major barrios were also interviewed to verify and supplement the item pool generated by other sources; and key informants from major national and international institutions operating in the region were interviewed.

3. Varieties included were: IR-8, IR-5, IR-20, all developed at the International Rice Research Institute and C4-63, C4-63G developed at the University of the Philippines College of Agriculture. All these are short, stiff-strawed and highly nitrogen responsive varieties.

4. This refers not only to governmental materials but non-governmental also. For example, recognition by religious and educational hierarchies.

5. Sources used for Congressional recognition were: *The Congressional Record* and *History of Bills and Resolutions 1947-1971.*

6. Estimation of relationships (5)-(10) is by two stage least squares rather than ordinary least squares. This is because conceptually, problems of joint dependence are the issue.

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