AGRO – CLIMATIC REGIONAL PLANNING IN INDIA ROLE OF AGRO INDUSTRIES AND INFRASTRUCTURE

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AGRO - CLIMATIC REGIONAL PLANNING IN INDIA ROLE OF AGRO INDUSTRIES AND INFRASTRUCTURE*

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It has been estimated that foodgrains requirement for the year 2000 A.D would be around 240 million tonnes. The required increase in foodgrains production will have to be achieved along with the generation of employment to about 130 million persons, bulk of them in rural areas. Then two objectives call for optimization of crop and livestock production as per comparative advantage of various regions and acceleration of agro-processing activities to generate value added and employment.

Interregional relationships in agriculture are crucial because producing units are spatially distributed. Significant regional differences in climate, soil types and fertility, water resource development, capital availability and labour supply constraints along with lack of resource mobility among regions cause a differential comparative advantage among regions in production of certain crop and livestock commodities. However, the comparative advantage, production possibilities, policy alternatives and resource development needs of a region are not static over time. The development possibilities and comparative advantage continuously change with technological progress in

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agriculture. Therefore, a continuous consideration of new possibilities and interregional relationships is required for an efficient spatial allocation of production and resources in agriculture.

An increasing number of countries have begun the process of application of interregional programming models for agricultural policy formulation and evaluation to achieve efficient spatial allocation of production and resources. There are three basic prerequisites for building an interregional programming model for agriculture in a particular country : (1) the existence of a mathematical tool to formulate and solve the problem, (2) availability of computing facilities of the required magnitude, and (3) availability of the vast amount of basic data for various homogeneous regions (Heady and Srivastava (Eds), 1975).

Linear and nonlinear programming has now advanced theoretically to a point where there is no limit on the size and complexity of the models. Similarly availability and use of large computers has made it possible to solve even very complicated problems. The most difficult and costly part of the prerequisite of building an interregional programming model for the country is the compilation of existing data and the process of collecting additional data for generating the coefficients on yields and production costs of various crops and livestock activities in each of the delineated regions. Collection of data is only a first step in developing the required coefficients. It also becomes necessary to develop checks and cross checks to ensure the comparability of the data in different regions.

In India, the pioneering effort has recently been made by the Planning Commission to generate such a data by dividing the country into 15 regions delineated on the basis of a commonality of agro climatic factors like soil type, rainfall, temperature, water resources etc. The 15 regions are : i) Western Himalayan Region; ii) Eastern Himalayan Region; iii) Lower Gangetic Plains Region; iv) Middle Gangetic Plains Region; v) Upper Gangetic Plains Region; vi) Trans - Gangetic Plains Region; vii) Eastern Plateau & Hills Region; viii) Central Plateau & Hills Region; ix) Western Plateau & Hills Region; x) Southern Plateau & Hills Region; xi) East Coast Plains & Hills Region; xii) West Coast Plains & Ghats Region; xiii) Gujarat Plains & Hills Region; xiv) Western Dry Region; and xv) The Islands Region.

An overall development profile of each delineated region has been attempted to be formulated through optimal mix of land stock management, crop production, animal husbandary, aquaculture, horticulture, forestry and agro - processing activities.

The efforts to optimize crop, livestock and agro-processing activities can be divided into six scenarios as given in Table 1. The apriori expectation about the change in the level of the above mentioned variables as we move from scenario I to scenario VI is given below:

$$I_1 \leq I_2 \leq I_3 < I_4 < I_5 < I_6$$

$$O_1 \leq O_2 \leq O_3$$

$$V_1 = V_2 = V_3 = 0, \quad V_4 < V_5 < V_6$$

$$\text{Total Income } (Y_i) = Y_{oi} + Y_{vi}, \ i = 1 \ldots 6$$

$$Y_{v1} \ldots Y_{v3} = 0$$

$$Y_{o1} \leq Y_{o2} \leq Y_{o3} \leq Y_{o4} \leq Y_{o5} \leq Y_{o6}$$

$Y_{v4} = Y_{o3} + \delta_1$;
δ_1 is the value added during the first level processing

$Y_{v5} = Y_{v4} + \delta_2$,
δ_2 is the value added during the secondary, and tertiary level processing

$Y_{v6} = Y_{v5} + \delta_3$,
δ_3 is the value added during the by-product level processing

$E_1 \leq E_2 \leq E_3 < E_4 < E_5 < E_6$

This paper is designed to (i) Comment on the work on agro-climatic regional planning done so far, (ii) Discuss the role of agro processing industries in agro climatic regional planning exercise underway, (iii) Comment on the data collected on infra-structure activities, and (iv) Comment on the data base required for modelling and optimization of activities in each zone, keeping the above mentioned six scenarios in mind.

COMMENT ON THE PHASE I WORK : AGRO CLIMATIC REGIONAL PLANNING

The data collected for each of the 15 delineated regions has been presented in two parts . An overview document (GOI(b),1989) presents the highlights of strategy for each zone. Agro climatic zones : profile and issues document (GOI(c),1989) presents the detailed profile along with the data for each zone. The information presented in the detailed profiles is mostly descriptive and the aggregate data from records is presented in tabular form in annexures.

While this is a pioneering step in itself, for this information to be eventually used for formulating interregional programming

Table 1

Various Scenarios for Optimization of Crop, Livestock and Agro-processing Activities

Scenario	Inputs (I)	Crop and Livestock Production (O)	Value Added (V)	Income Crop Production (Y_o)	Net Value Addition (Y_v)	Employment E
I Existing Situation	I_1	O_1	V_1	Y_{o1}	Y_{v1}	E_1
II Optimization of Crop Livestock production (Resource Endowment)	I_2	O_2	V_2	Y_{o2}	Y_{v2}	E_2
III Optimization of Crop and Livestock Production (Resource Endowment and Demand levels of consuming centres and transportation flows)	I_3	O_3	V_3	Y_{o3}	Y_{v3}	E_3
IV Optimization of Crop and Livestock in III and Primary Processing	I_4	O_3	V_4	Y_{o4}	Y_{v4}	E_4
V Optimization of Crop and Livestock in IV and Secondary Tertiary, processing	I_5	O_3	V_5	Y_{o5}	Y_{v5}	E_5
VI Optimization in IV + By-product processing	I_6	O_3	V_6	Y_{o6}	Y_{v6}	E_6

models for crop and livestock activities, a variant of the following generic model (Srivastava and Mann 1972) is to be formulated and empirically solved :

$$\text{Min } f(c) = \sum_{k=1}^{V} \sum_{i=1}^{N} C_{ki} \quad X'_{ki} + \sum_{i=1}^{V} \sum_{m=1}^{W} \sum_{\substack{m'=1 \\ m \neq m'}}^{W} b_{imm'} \, z_{imm'}$$

where

C_{ki} = cost of producing k_{th} commodity in i_{th} producing region.

X'_{ki} = level of production of k_{th} commodity in i_{th} producing region.

$b_{imm'}$ = cost of transporting a unit of the i_{th} product transported from (to) the m_{th} consuming region to (from) the m'_{th} consuming region

$Z_{imm'}$ = quantity of i_{th} product transported from (to) the m_{th} consuming region to (from) the m'_{th} consuming region.

N = total number of producing regions in the model.

V = total number of crop and livestock activities in the model.

W = total number of consuming regions in the model.

Equation (1) is to be minimised subject to atleast the minimal basic restraints presented below :

<u>Demand</u> – <u>Supply Balance</u> : The demand for each crop and livestock production within the region and exports to or imports from other regions. This can be written as follows:

$$D_{im} = \sum_{i=1}^{r} a_{ki} \quad X_{ki} + \sum_{m'=1}^{s} t_{imm'} \quad z_{imm'} \qquad (2)$$

where

D_{im} = demand for the i_{th} product the m_{th} consuming region.

a_{ki} = yield per hectare of the k_{th} producing activity in i_{th} producing regions.

X'_{ki} = level of production hectares of the k_{th} activity in the i_{th} producing region.

r = number of producing regions in the m_{th} consuming region (it is assumed that a consuming region combines a number of producing regions.)

s = number of commodity flows in and out of consuming region.

$t_{imm'}$ = amount of i_{th} product transported from (to) the m_{th} consuming regions to (from) the m'_{th} activity.

$Z_{imm'}$ = level of the imm'_{th} transportation activity, i.e, the activity which transport the ith product from (to) the mth consuming region to (from) the m'th consuming region.

Land Restraint : There is a limited supply of crop land for production of all the crops combined. This is written as :

$$L_{ti} \geq \sum_{k=1}^{V} X'_{ki} \qquad (3)$$

where

L_{ti} = the total amount of cropland available for the k = V crop producing activities in ith producing region.

Non - Negativity Restraint : The crop producing activities cannot be negative. Similarly, the transportation activities also cannot be negative. This is written as follows :

$$X'_{ki} \geq 0 \ , \qquad Z_{imm'} \geq 0 \qquad (4)$$

In actual estimation, we will have to introduce various other types of restraints to make the model more relevant to the conditions of Indian agriculture.

It can be seen from this model that it will be necessary to generate the required coefficients and projections of demand and transportation cost of various commodities from producing to consuming regions. Although input-output coefficients may vary even between farmers in the same regions, some amount of aggragation and representative forms situation is necessary for modelling. Such a model would make the following implied assumptions for the homogenous regions so delinated:

1. There are N uniqoe, spatially seperated but interdependent production regions, with many producers of various crop and livestock commodities.

2. All producers in a specific production region have only the choice of producing the same (homogenous) products or product mixes, and quality is uniform between regions.

3. All producers in a specific production region have identical input - output coefficients and use the same production.

4. Input - output coefficients are constant within the relevant range, i.e., constant returns to scale exist.

5. An acre of a crop land can be substituted for an acre of another crop land at a constant rate within each region.

6. Total production in each region is limited only by fixed quantities of land and water resources suitable for crop production.

7. The economic objective of each producer is profit maximization.

8. Total consumption requirements of each crop and livestock product are exogeous, determined by annual per - unit requirements of the human and livestock populations at a point in time.

If the above mentioned assumptions are to be at least plausible, 15 agro climatic zones would not suffice and ultimately each zone would have to be broken down into sub zones such that generated input and output coefficients are homogeneous for that sub zone. In this context the effort of further dividing the 15 agro-climatic regions into 73 subzones (GOI (c),1989) have to be critically examined for their adequacy in terms of homogenity.

It is in this context that the agro climatic regional planning work has now to move from descriptive to quantitative aspects purposively at a more disaggregated level. The enormous effort required to collect data and near impossibility of figures gathered in different regions compatiable at the initial stages, suggests initial building of simple models and the interpretations of the results only as general policy guidelines. Efforts should continuously be made to strengthen the database so that more complex but realistic models be attempted for policy formulation.

It may be noted that this effort will only take up to scenarios II and III. Planning for value added from agro-processing will require efforts in the direction of scenario IV, V and VI.

II ROLE OF AGRO PROCESSING IN AGRO CLIMATIC REGIONAL PLANNING

An agro-industry is an enterprise that processes bio-mass, i.e. agricultural raw materials, which include ground and tree crops as well as livestock and fisheries, to create edible or usable forms, improve storage and shelf life, create easily transportable forms, enhance nutritive value, and extract chemicals for other uses.

As the products of agro industries are both edible and non edible, the agro-industries can be classifed as agro-food industries (or merely food processing industries) and agro-non-food industries.

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* This section has been extracted from U. K. Srivastava " Agro - Processing Industries : Potential, Constraints and Task Ahead" , 1989.

The agro-industry provides the crucial farm-industry linkage backward linkages (supply of credit, inputs and other production enhancement services) and forward linkages (processing and marketing), adding value to the farmer's produce, generating employment opportunities, and increasing the farmer's net income. This in turn motivates the farmer for better productivity and further opens up possibilities of industrial development. The agro-industry generates new demand on the farm sector for more and different agricultural outputs which are more suitable for processing. An agro-processing plant can open up new crop and livestock opportunities to the farmer and thus increase the farm income and employment (Austin, 1981).

Derived from the raw material processed by them, agro industries display unique characteristics seasonality, perishability, and variability (Srivastava, 1981). The ground and tree crops, fisheries, and livestock undergo a reproductive cycle. Therefore, agro-industries have to procure raw materials only in the season (or there are wide fluctuations in the availability between the seasons), while the processing operations continue for a longer period and the demand for the products is round the year. The raw materials processed by the agro-industries are often perishable (at least in the food processing industries), and therefore greater speed in handling, storage, and processing is required. Unlike non-agro-industries, the raw materials obtained and processed by the agro-industries are often of varying quality.

These characteristics make the procurement sub system for raw materials the crucial determinant of the performance of these enterprises. Agro-industries are amenable and more viable to be located nearer to the source of raw material allowing a spatial distribution of industries (reducing regional disparities in industrialization). . Agro industries also have large export potential.

The potential for agro-processing can be viewed in two ways: 1. The degree of processing of primary raw material, and 2. Degree of processing of all the by-products under the commodity system.

Degree of Processing

The degree of processing of various raw materials varies from cleaning and grading of apples to milling of paddy and cooking, mixing and chemical alteration that create instant and ready to eat foods (Table 2). It may be noted that as the transformation of raw materials moves from Category I to IV, the value added as well as the price of finished products also rises. For example, the shrimp exports from India have been normally in the block frozen form (after being deheaded, devi-ened and shelled). More recently the effort has been to export the shrimp after processing it through instant quick frozen (IQF) method. These exports are expected to fetch 50% to 70% higher value than in block frozen form (Srivastava et al. 1989). Similarly, tea exported in branded tea packets fetches additional value. The magnitude of value addition by the higher degree of processing in leather is illustrated in Table 3. Subsequent secondary and tertiary processing of semi-finished leather raises the value of index to 33%.

As we move from preliminary degree of processing to higher degree of processing, capital investment, technologial complexity and managerial requirements also go up. Therefore, it has to be examined for each commodity as to what level of transformation is to be encouraged in the light of the present status and profile of the industry, technology options available, investment required, purchasing power of the target group in the domestic market, and specification of the international markets (Srivastava, 1989).

Degree of Processing of All the By-products

The agro-industrial potential becomes manifold when the processing possibilities of the entire commodity system are taken into account (Sah and Srivastava, 1985). For example, a farmer cultivates a paddy plant, and these plants produce the following : straw about 50% by weight), hisk (about 10.5% by weight), bran (about 3.5% by weight) and rice kernel (about 36% by weight). Two recent studies (Gaikwad, 1986 and Gaikwad & Gupta, 1987) has indicated that with an initial investment of Rs. 2 to 3 crores, each block of 10,000 hectare under paddy crop with two paddy seasons in a year and 4 MT/ha of production has a potential of supporting a complex of processing industries (rice mills, solvent extraction plant for rice bran oil, processing of husk for a variety of products, and straw paper/board mills). This yields 107% net value added on the raw material price. Such exercises can be done for all commodity by-product systems.

Similarly in animal based products we get the following raw materials : meat, blood, bones, hides, skins, glue stock, horns and hoofs, wool, hair, feathers, glands and casings (Mann, 1978; Bhat, Menon and Srivastava, 1989). Processing of all these raw materials opens up large value addition possibilities. In remote rural areas, the farmer have been been able to recover only hides and skins, and the opportunity for processing of other by-products is lost.

Table 2

Categories of Agro-Industry by Levels of Transformation Process

I	II	III	IV
Manual-Mechanical*	Mechanical*	Mechanical-Chemical*	Chemical*
Types of Processing Activity			
Cleaning Grading	Ginning Milling Cutting Mixing	Cooking Pasteurization Canning Dehydration Freezing Weaving Extraction Assembly	Texturization Chemical alteration
Illustrative Products			
Fresh fruits Fresh vegetables Eggs	Cereal Grains Meat Spices Animal feeds Jute Cotton Lumber Rubber	Dairy products Fruits and vegetables Meats Sauces Textiles & garments Oil Furniture Sugar Beverages	Instant foods Textured vegetable Products Tyres

* This classification has been added by the author-

Source : Austin, p.4

Table 3

Theoretical Value Accrued to Hides and Skins When Processed into Different Stages

(Value in Rs. Crores)

	Available (1986) (Million Pieces)	Value (at National Prices)	Value of semitanned leathers	Value of finished leathers	Value if all finished leather is converted into products	Value if 75% of the finished leather is converted into products
Value addition index			(100)	(150)	(333)	(250)
Cattle hides	22	193	290	434	965	723
Buffalo hides	16	134	201	302	670	503
Goat skins	75	375	563	843	1875	1405
Sheep skins	31	1555	233	349	775	582
Total		2257	1287	1928	4285	3213

Source: K. Seshagiri Rao, "India's Leather Industry - Its Potentialities and Problems", in Srivastava and Vathsala, 1989, pp.243

The above conceptual framework for generating ideas for agro industries in each sub zone requires the assessment of existing units in the area and the need for the additional units for processing the increased raw materials. The constraints on acceleration of production for domestic market or exports can be identified in a systems framework right from the input supply to farmers and production of raw materials to output processing and marketing (Figure 1).

The input supply and production system exercises the major constraint on processing and marketing of products (Kulkarni and Srivastava, 1985). Similarly the functioning of the processing system and the policy environment also exercises a restrictive influence on the development of markets (both domestic and international) for the value added and processed agro-based products.

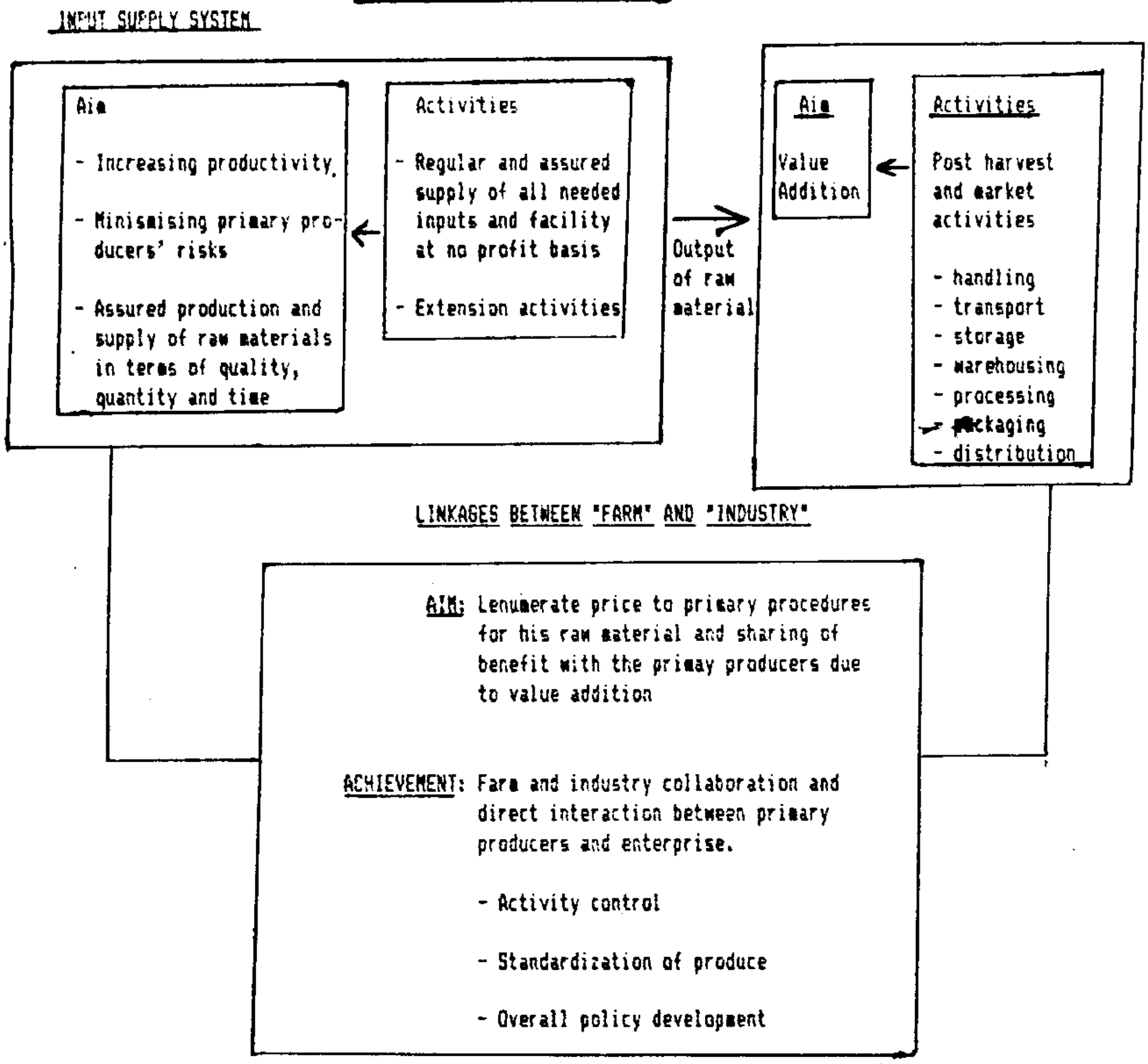
The data collected for each of the 15 agro climatic zones agro processing activities is very scratchy and often does not even mention the ongoing activities in the zone before making some suggestions on agro-processing potential. A study done by the Planning Commission also suffers from the same problem (GOI(e),1989).

Recently, Operations Research Group has done a comprehensive study on agro-processing industries at the request of the Agro-climatic Regional Planning Unit of Planning Commission, Ahmedabad (ORG,1989). This study basically analyses the ASI(Factory Sector) data for selected zones and also presents the results of its own survey for 200 units. The study is extremely useful as a first step. The following observations may, however, be made on this study in the context of its usefulness for planning for respective agro-climatic regions:

1) The study uses agragate ASI data (GOI(a),1989) for selected States (falling in selected zones) and presents the analysis about the features of agro-industries. The results only reconfirm the feature published and widely known for agro-industries (See Srivastava, Agro-processing industries, 1989).

2) This data has been further divided into 4 zones within an agro-climatic region. But the same is still not co-terminus with the sub zones.

Figure 1: THE SYSTEMS FRAMEWORK



3) The data does not provide indication on the utilization of potential as defined in Section II in this paper. (Using the commodity systems framework and degree of processing of primary raw material). It is known that potential of agro-processing based on the same primary raw material income manifold once, it is viewed as indicated in Section II (See also Srivastava, Agro-processing Industries, 1989).

4) In the absence of (3) above, the recommendations for additional units do not emerge from a framework which can utilize the potential in a systematic way (including high degree of processing and using all the by-products of the commodity system).

Therefore, this study of belt tries to approach scenario IV defined above. If the value added and employment potential of scenario V and VI has to be explored, the study has to be much more comprehensive than the present one. The technological alternatives for higher value addition and by-product process have to be superimposed on the crop and livestock production in the homogenous sub zones within the agro-climatic regions initially delineated.

III INFRASTRUCTURE FACILITIES

The infrastructure facilities are crucial for faciliating the process of setting up of agro industries in a region. The data collected for each of the agro climatic region only describes the number of agricultural produce markets. At best some of the profiles also indicate the length of the roads, few other transport and banking facilites. For proper planning in agro climatic zones it is necessary to have data on the following: (1) Marketing channels (including co-operatives); (2) Transportation and Packaging facilities; (3) Warehousing and storage facilities (including cold storage atleast for fisheries and (fruits & vegetables); (4) Existing programmes and Organizational Structures at the grass root level for the promotion of production of specific commodities. (For example Fish Farmers Development Agency Programme operates in 300 districts in this country and this is expected to accelerate inland fish production).

This data would then be useful in generating the cost coefficients for transportation of fresh and processed produce from producing to consuming regions and the marketing costs. The lack of infrastructural facilities also acts as a constraint in actualizing the agro-processing potential.

IV DATA BASE REQUIRED FOR MODELLING AND OPTIMISATION OF ACTIVITIES IN EACH ZONE

Optimization of crop and livestock production

The formulation of a meaningful programming models including crop and livestock activities would require the following data to determine the parameters for empirical solution : (1) Projected demand estimates for various crops and livestock in consuming regions; (2) Projected cropwise yield estimate per hectare in various producing regions and yields of livestock products for each producing region; (3) Transport cost between producing regions within a consuming region as well as from one consuming region to another; and (4) Projection of production cost crop wise per hectare and livestock products in various producing regions. (Besides these, data will also be needed to specify the parameters of restraints. Most of the required data for fixing up of restraints levels will come from the plan objectives (Heady and Srivastava (Eds.) 1975).

In India, fairly detailed demand projections for crop and livestock products are available. Similarly the detailed crop yield per hectare (compiled by Directorate of Economics and Statistics, Ministry of Agriculture, Government of India) can be used to project yield of various crops in a time period to be analysed by the model. Transportation cost structure can also be easily arrived at from the railway freights as most of the interstate transport of crops are by rail.

The critical data required by the model would be input-output data for various crops, livestock products and agro-processing activities. In India various cross section surveys have been made and these have yielded a set of data from time to time. Most recently the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India has initiated the cost of cultivation studies covering a large number of major crops in a very broad geographic coverage on a time series basis. These data should be used to arrive at the required input - output coefficients. Once this data is used for generating input - output coefficients for interregional programming models, the needed improvements and strengthening can also be taken up. As the data is on time series basis, the needed updating of coefficients from time to time would not create any problem.

Agro-processing Industries.

As indicated above, the data collected in the first stage of work from 15 agro climatic regions has very little information on agro-industries in each area. In India a very large proportion of agro-industries are in the unorganised sector (Table 4). In case of agro-industries in the organised sector, the Annual Survey of Industries brought out by Central Statistical Organization (CSO) is the most important publication. If this data is to be used for agroclimatic regional planning, disaggregated information for each unit will have to be obtained from CSO[1]. Such an information is not available in published form today.

In case of unorganised sector also, the information is available for various units with CSO (although not as detailed and as systematic as in the case of organised sector). This data has to be also systematized and updated by the teams working on each agro climatic region. The data for infrastructure planning need

Table 4
Net Value Addition from Registered and Unregisterd Units

Years	Percentage Share of Net Value from	
	Registered Units	Unregisterd Units
1970-71	52.2	47.8
1980-81	49.9	50.1
1984-85	51.3	48.7
1985-86	42.7	55.3
1986-87	42.6	57.4

Note: These units includes commodities like food products, beverages, tobacco and tobacco products, textiles, wood and wood products - furniture and fixtures, paper and paper products and leather and leather and fur products.

Source: Central Statistical Organisation National Accounts Statistics - 1980-81 to 1986-87, New Delhi, 1989.

1 The unitwise data will still however, have to be grouped for each subzone so that confidentiality of operations of units surveyed is not violated.

to be collected at the grass root level and the same has to be compiled by each team which works on agro climatic regions and sub zones.

To attain the scenarios V and VI, data colloection from the field would not suffice. In these scenarios, technology will have to enquire of growth. Technological alternatives for higher value added products, from same primary raw materials and also for by-product utilization will have to be generated and used in assessing the agro-processing potential of each zone.

SUMMING UP

While the initial attempt by the Planning Commission to introduce Agro-climatic Regional Planning is pioneering in nature, it is at best only indicative and is amenable to arrive at some general strategic guidelines. In the subsequent phases, the effort should be made to delineate more homogenous producing regions and consuming centres. In addition, the effort should now be to move from descriptive to modeling and quantitative analysis by the collection and compilation of the type of data and crop and livestock activities for each region and its sub zones.

Similarly the available information on agro industries need to be segregated at the regional and sub zonal level so that this forms the base for generation of alternatives for future growth of opportunities (within the framework indicated in Section II of this paper) with the additional raw material projected to be available for processing due to appropriate policies for adjustment of production in the light of each regions comparative advantage. In this context, association of a technology development institution like Central Food Technology Research Institue would be extremely helpful in generating alternatives.

Acceleration of agro-industries in future would also require acceleration of processing compatiable raw material at cheaper prices(Chadda, 1989). These agro industries are not only reactionary but also active in generating such raw material from crop and livestock resources.

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