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SMALLHOLDER FARMERS IN INDIA: FOOD SECURITY AND AGRICULTURAL POLICY

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PREFACE

India's small-holder farmers (those owning less than 2.0 ha of farmland) comprise 78 percent of the country's farmers, but own only 33 percent of the total cultivated land; they nonetheless produce 41 percent of the country's food-grains. Their productivity is somewhat higher than that of medium- and large-size farms. Moreover, their marketable surpluses are increasing. In the nation's food-security interest, such increase must be sustained. Those features notwithstanding, small-holder families, together with the families of land-less agricultural workers, constitute the bulk of India's hungry and poor.

During the 1990s, annual rates of increase in agricultural productivity and yields were less than in the 1970s and 1980s; it is thus noteworthy that in the 1990s the investments in agriculture - in its research, technology, and infrastructures - were substantially less than in the two preceding decades. Worrisomely, new analyses here presented suggest that during 2002-2004 the growth rates in the index of *total agricultural production,* in the all-cereals *yield,* and in the all-cereals *production,* shall each fall below the forecast rate (1.3%/ann) of human-population increase.

Hence there is crucial need - and national self-interest - for policy actions to reverse the trend of decreasing investment, and to strengthen and sustain the productivity and livelihood of the small-holder sector and its value-addition component. Such actions must include strengthening of agrarian reform and of land-lease markets and of infrastructures and institutions, creating off-farm employment through small- and medium-size enterprises, and developing and diffusing size- and scale-neutral technologies that save land and costs, and that enhance crop and livestock yields. Notably, food insecurity and poverty are each less for those rural households that own a piece of land (however small) and/or a buffalo. Correspondingly, these institutional and technical interventions shall need to be complemented by expanded rural education and skills development, especially for rural women, and by information systems and rural-friendly mechanisms to access them.

There must also be action to improve domestic agricultural-produce markets and co-operatives. Internationally - and recognizing the power and the opportunities within the World Trade Organization - there are needs for pro-poor safety nets to counter imports-induced instability, and for supports, including market intelligence and quality-control mechanisms, to facilitate export of small-holding products. Government initiatives within the international trade arena shall be crucial to help ensure that India's small-holders are competing in an arena in which the playing pitch is level.

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ACRONYMS and ABBREVIATIONS

ACIAR	Australian Center for International Agricultural Research
AGRISNET	Agricultural Informatics and Communication Network (NIC-NET-based)
APSA	Asia and Pacific Seed Association
DISNIC	District Information System for National Informatics Centre
FAO	Food and Agriculture Organization of the United Nations
FarmNet	Farmer Information Network for Agricultural and Rural Development
FIVIMS	Food Insecurity and Vulnerability Information and Mapping System
GCA	Gross Cropped Area
GDP	Gross Domestic Product
GIEWS	Global Information and Early Warning System
GM	Genetically-modified
Ha	hectare
ICAR	Indian Council of Agricultural Research
ICTs	Information Communication Technologies
IFPRI	International Food Policy Research Institute
IMF	International Monetary Fund
IPM	Integrated Pest Management
IPNS	Integrated Plant Nutrients Management
IT	Information Technology
kcal	kilocalorie
Mha	million hectare
NCA	Net Cropped Area
NGO	Non-Governmental Organization
NIC	National Information Centre
NSS	National Sample Survey
OECD	Organization for Economic Co-operation and Development
PDS	Public Distribution System
RAP	Region of Asia and the Pacific (UN System)
SEAMEO	Southeast Asian Ministers of Education Organization
SEARCA	Southeast Asia Research Center for Agriculture
SMEs	Small and Medium Enterprises
TFP	Total Factor Productivity
TRIPS	Trade-Related Aspects of Intellectual Property Rights
VERCON	Virtual Extension, Research, and Communication Network
WAICENT	World Agricultural Information Centre
WTO	World Trade Organization

I. INTRODUCTION

Commenting on the key findings of India's first set (1950s) of Studies of the Economics of Farm Management, Amartya Sen (1964) highlighted the inverse relationship between farm size and productivity. Collective farming was deemed inappropriate for India, and the importance of land reforms - on efficiency grounds - was recognized. However, Green-Revolution technologies seemed to change this relationship under some circumstances (Saini, 1971). Nonetheless, this current analysis (of most of the household-level data-sets on costs of farm production for the 1980s and 1990s) suggests that small-holder farmers are perhaps the more-productive. Their vital contribution to India's food and agricultural economy and to its national food security results from the small-holders' responsiveness to public policies and to national investments in agricultural research and development and in public infrastructure. Thus, the current declines in public investment in these critical public goods raises much concern for future agricultural growth. There are strong and urgent needs for policy interventions to reverse these declining trends of public investment in agriculture and its infrastructures.

During fifty years and more, India made immense progress towards security of food and livelihoods. Since 1950, population almost tripled, but food-grain production more than quadrupled: there was thus substantial increase in available food-grain per caput. India is now among the largest producers of rice, wheat, pulses, fruits, vegetables, and milk. This agricultural transformation - and the associated broad-based economic growth - have helped double income per person and life expectancy, lessen poverty incidence by nearly one-half, and render the country self-sufficient in food. Famine and mass starvation belong to the past.

But all this notwithstanding, India is home to one-fourth (208 million) of the world's total (800 million) of under-nourished people. Moreover, the intensity of the hunger among those undernourished is also high. Child malnutrition is here the world's highest: one in four Indian children is seriously under-nourished. Anaemia affects more than half of the pre-school children and more than half of the pregnant women.

Furthermore, the extent and intensity of hunger matches closely the extent, intensity, and nature of poverty: India's total of poor persons (250 million) is comparable to its total (208 million) of under-nourished. Thus, one-fifth of the world's poor live in India - the largest total for any single country. Nationally, the country is self-sufficient in food production and availability; however, many poor households lack the resources wherewith to purchase the available food.

Since 1950, agriculture's share of GDP declined substantially; but there was minimal decrease in the numbers of persons dependent on agriculture. Consequently, agriculture contributes only 26 per cent of national GDP, but employs 60 per cent of the workforce. Since it has been agriculture-led broad-based economic growth that lessened poverty - particularly rural poverty - recent (and undesirable) trends in agricultural growth and in associated rural developments raise great concerns. The massive increase in national population (notwithstanding a recent decrease in its rate of growth), and the substantial increase in incomes and purchasing power, together increase the annual requirement for food-grains by four million tonnes; there are corresponding increases in the requirements for livestock, fish, and horticultural products. These requirements shall further stress the decreasing and degrading resources of land and water.

Notwithstanding these requirements, investments and capital formation in agriculture are declining. Growth in total factor productivity has slackened. Similarly, and despite India's relatively-low average yields for many crops and commodities - with implication that there is substantial scope to raise those yields - current yield growth is less than heretofore, and there are suspicions that some production systems "may be fatigued". Worrisomely, the pace of poverty reduction may also be slackening.

In the mid-1990s, Lester Brown assessed China's accelerating demand for food- and feed-grains from its diminishing arable-land area, and posed the question: "who shall feed China?" To which the Chinese leadership responded " the farmers of China will feed China". Similarly, at the current juncture of India's agriculture, poverty, and hunger, one may ask: "who shall feed India?" India may perhaps draw strength from the *mantra* of *"Jai Kisan"* (hail the farmer) enunciated by the late Prime Minister Lal Bahadur Shastri, and thus assert that "the farmers of India will feed India". It must additionally be asserted that the task of feeding India shall reside with its cohort of small-holder farmers who constitute the overwhelming majority of the country's farmers.

II. WHY THE SMALL-HOLDER FARMER?

Small-holder farmers are vital for India's agriculture and rural economy. Small-holder farmers - defined as those marginal and sub-marginal farm households that own or/and cultivate less than 2.0 hectare of land - constitute about 78 per cent of the country's farmers (at Agricultural Census 1990-91). These small-holders owned only 33 per cent of the total cultivated land; their contribution to national grain production was nonetheless 41 per cent. Their contribution to household food security and poverty alleviation is thus dis-proportionately high - and is increasing. Moreover, as the national population increases, so does the number of small-holdings.

The 1990s witnessed high GDP growth rate. Nonetheless, there has been no accompanying decrease in the (high) proportion of the national workforce that depends upon agriculture for its livelihood. Neither the cities, nor the large-scale commercialized agriculture, have provided employment to the many small-scale farmers and rural poor. National (and state) policies for agriculture and for rural development to lessen poverty and hunger must accommodate this (internationally) atypical circumstance.

Small-holder families constitute more than half of the national population. It is thus disappointing that notwithstanding their substantial and increasing contribution to the national food supply and to agricultural GDP, these small-holder families nonetheless constitute more than half of the nation's totals of hungry and poor. Policies and programmes to lessen poverty and food insecurity, and to enhance equity and sustainability of incomes and livelihoods, should thus seek to achieve an agriculture-led broad-based economic development - and to do so by according highest priority to small-scale agriculture.

The questions are here posed: is the continuance of Indian hunger and poverty a consequence of the smallness of the preponderant majority of the nation's farms? . . . or may the productivity of those small farms be so increased as to allow the small-holder families - and the nation with them - to escape from hunger and poverty? We shall reason in support of the second (hopeful) option. But the hope will be realized only when the small-holders are empowered to access the crucial production resources. These resources are several: land, water, energy, and credit; appropriate technologies, and opportunities to develop the skills and to access the information wherewith to use them; functional and fair markets for products and inputs; health care and sanitation; and education and reproductive and social services. Given the national and international policies that facilitate access to such resources, there would be confident expectation that small-scale agriculture could and would achieve higher production and income and that the livelihoods of small-holder families and communities would be enhanced.

How can the requisite empowerment be accomplished, and the small-holders enabled to accept the challenges and opportunities of bio-technology, of informatics, and of globalization? What socio-economic policies shall facilitate the empowerment? The latter sections of this paper respond to these questions. Earlier sections report the preparatory analyses - of small-holder operations and contributions to household and to national food security - wherewith to frame that response.

III. SMALL-HOLDER CONTRIBUTIONS TO AGRICULTURE

Between 1971 and 1991, India's total number of farm holdings (aggregate for all farm sizes) increased from 70.5 million to 106.6 million (Table 1). Within those totals, the small-size holdings - encompassing the categories *sub-marginal* (less than 0.50 ha), *marginal* (0.50 to 0.99 ha), and *small* (1.00 to 1.99 ha) - increased from 49.1 million (70 per cent of the 70.5 million total) to 83.4 million (78 per cent of the increased total of 106.6 million). Correspondingly, the average size of holding (all sizes) decreased from 2.28 ha (1971) to 1.55 ha (1991) as the number of holdings and of farm families increased - the total agricultural-land area remained almost unchanged. Significantly, the average size of those holdings smaller than 2.00 ha did *not* decline (Table 1); but the average size of holdings larger than 4.00 ha decreased from 9.18 ha in 1971 to 7.95 ha in 1991 - thereby lessening the national-average farm size. This trend has *positive* policy implications for farm efficiency, since we shall later suggest (as did Sen for the 1950s) an inverse relationship between productivity and farm size. Table 1 shows also that the land per caput decreased for almost all farm-size categories - indicating that the attainment of household food security is intensifying the pressure on the land resource.

Table 1: Distribution of holdings by farm-size category - All India - 1971 and 1991

Farm-size category	Number of holdings (million)		Net cropped area (million ha)		Average size (ha/holding)		Land per caput (ha/cap)	
	1971	1991	1971	1991	1971	1991	1971	1991
Sub-marginal	23.2 (33)	42.7 (40)	5.4 (3)	9.8 (6)	0.23	0.23	0.046	0.046
Marginal	12.5 (18)	20.6 (19)	9.1 (6)	15.0 (9)	0.73	0.73	0.140	0.124
Small	13.4 (19)	20.1 (19)	19.3 (12)	28.8 (18)	1.44	1.43	0.240	0.217
Medium	10.7 (15)	13.8 (13)	30.0 (19)	38.4 (23)	2.81	2.76	0.426	0.373
Large	10.7 (15)	9.2 (9)	98.3 (60)	73.4 (44)	9.18	7.95	1.257	0.994
All Farms	70.5 (100)	106.6 (100)	162.1 (100)	165.5 (100)	2.28	1.55	0.400	0.258

Source: Agricultural Census 1970-71 and 1990-91; Figures in parenthesis: share (%) in the all-farms total.

In 1991, small-size holdings, constituting 78 per cent of all holdings, commanded 33 per cent of the total net cropped area, while medium- and large-size holdings, constituting 22 per cent of the farmers, commanded 67 per cent (Table 1). About three-fifths of all holdings were marginal or sub-marginal, and about one-fifth were small. However, sub-marginal holdings - comprising 40 percent of all holdings, commanded only 9.8 per cent of the total agricultural-land area. Contrastingly, large-size holdings (> 4.00 ha) accounted for only 9 percent of all holdings but commanded 44 per cent of the area. Between 1971 and 1991, the proportion of holdings smaller than 1.00 ha increased from 51 to 62 per cent.

Gross cropped area (GCA - Table 2) increased by 21 million hectares (13 percent) between 1971 and 1991 - a result primarily of increases within the small-size holdings; Table 1 indicated that during the same period there was much less increase - 3 million hectares (2 percent) - in net cropped area. The last two columns of Table 2 permit a determination of the extent to which the increase in *net* cropped area is a consequence of increase in *gross* cropped area. For the *smaller* farms (sub-marginal, marginal, small) in aggregate, the proportional increase in *gross* cropped area is typically 10 percentage points higher than the proportional increase in *net* cropped area; for the larger (medium, large) farms, the corresponding figure is typically 7 percentage points. There is thus some slight evidence that the smaller farms intensified somewhat more than the larger farms; the large farms nonetheless intensified creditably. However, the trend to smaller farm-size, and the somewhat greater intensification (and possibly greater diversification) achieved on the smaller farms, together suggest that the small and marginal holdings may expect to play a prominent part in modernizing Indian farming procedures and in achieving increased and sustainable productivity and profitability.

Table 2: Changes (1971-1991) in gross and in net cropped area (GCA, NCA) by farm-size category

Farm-size category	Gross cropped area (million hectare)		Change in GCA: 1971 to 1991		Change in NCA: 1971 to 1991
	1971	1991	Million ha	Percent	Percent
Sub-marginal	6.4	12.4	+ 6.0	+ 93	+ 81
Marginal	10.5	18.3	+ 7.8	+ 74	+ 65
Small	20.8	33.0	+12.2	+ 59	+ 49
Medium	31.3	42.6	+11.3	+ 36	+ 28
Large	89.0	72.9	-16.1	- 18	- 25
All farms	158.1	179.3	+21.2	+ 13	+ 13

Source: Computed from Agricultural Census, 1970-71 and 1990-91

Table 3 summarizes the proportionate contribution by farms of various sizes to *food-grains* production at 1971, 1981, and 1991. Notably, holdings smaller than 2.00 hectare - which at 1971 accounted for only 28 per cent of total food-grains production - were by 1981 contributing 34 per cent, and by 1991 41 per cent. (Table 3). In contrast, the proportionate contribution from medium-size holdings increased by a mere 3 percentage points during 1971-1991, while that from the large holdings declined from 51 to 35 per cent. For individual crops, and between 1971 and 1991, small-size holdings increased their share in production of *rice* from 38 to 49 percent, of *wheat* from 26 to 40 per cent, of *coarse cereals* from 19 to 29 per, and of *pulses* from 19 to 27 per cent. These substantive increases in the proportionate (and in the absolute contributions) from the smaller-size holdings is ascribed to favourable changes in agrarian structure, and to impressive adoption of new technologies and intensive use of modern inputs on those small-holder farms.

For *non-food-grains* production (Table 4), *large* farms had the dominant shares at 1971 for *oilseed* (63 per cent) and for *cotton* (77 per cent); by 1991, these shares had declined to 48 and to 53 per cent respectively; there were compensatory increases in the contributions by the small- and medium-size holdings. For *sugarcane* and *jute,* the con-

Table 3: Proportionate contribution (%) to food-grains production by farms in various size categories at 1971-1981-1991

Crop	Farm size	1971	1981	1991
Rice	Sub-marginal	7	9	11
	Marginal	11	13	15
	Small	20	21	23
	Subtotal < 2.0 ha	38	43	49
	Medium	24	25	25
	Large	38	32	26
Wheat	Sub-marginal	5	7	9
	Marginal	7	9	12
	Small	14	15	19
	Subtotal < 2.0 ha	26	31	40
	Medium	21	23	23
	Large	53	46	38
Coarse cereals	Sub-marginal	3	3	4
	Marginal	5	6	8
	Small	11	13	17
	Subtotal < 2.0 ha	19	22	29
	Medium	19	22	25
	Large	63	57	46
Pulses	Sub-marginal	3	4	4
	Marginal	5	7	8
	Small	11	13	15
	Subtotal < 2.0 ha	19	24	27
	Medium	18	20	22
	Large	63	56	51
All food-grains	Sub-marginal	5	7	9
	Marginal	8	10	12
	Small	15	17	20
	Subtotal < 2.0 ha	28	34	41
	Medium	21	23	24
	Large	51	43	35

Source: Computed from data in Agricultural Census and in Agricultural Statistics at a Glance, GOI

Table 4: Proportionate contribution (%) to non-food-grains production: Various farm-size categories, at 1971-1981-1991

Crop	Farm-size category	1971	1981	1991
Oilseeds	Sub-marginal	3	4	5
	Marginal	5	6	7
	Small	11	13	16
	Subtotal < 2.0 ha	21	23	28
	Medium	18	22	24
	Large	63	55	48
Sugarcane	Sub-marginal	5	6	9
	Marginal	8	10	14
	Small	16	19	23
	Subtotal < 2.0 ha	29	35	46
	Medium	25	27	26
	Large	45	38	28
Fruits & Vegetables	Sub-marginal	13	14	15
	Marginal	12	13	15
	Small	18	18	21
	Subtotal < 2.0 ha	43	45	51
	Medium	20	23	22
	Large	38	32	27
Cotton	Sub-marginal	*	1	1
	Marginal	2	2	4
	Small	6	9	15
	Subtotal < 2.0 ha	8	12	20
	Medium	15	20	25
	Large	77	68	53
Jute	Sub-marginal	8	10	18
	Marginal	11	18	19
	Small	28	28	28
	Subtotal < 2.0 ha	47	56	65
	Medium	25	26	21
	Large	27	17	14

Source: Computed from data in Agricultural Census and in Agricultural Statistics at a Glance, GOI.

tributions (proportionate and absolute) from the *smaller-size* holdings increased very substantially between 1971 and 1991: proportionate contribution to *sugarcane* production increasing from 29 to 46 per cent, and for *jute* from 47 to 65 per cent. Similarly, smaller-size holdings were the major producers of *vegetables* and *fruits,* contributing 51 per cent of the production in 1991. The increasing importance of small-holder agriculture to national production and to food security is clearly manifest.

Table 5 compares food-grains production at 1971 and 1991. For *all food-grains,* the production increment during those 29 years was 92 million tons per annum (Mt / an). *Rice* contributed 47 per cent, and *wheat* 50 per cent to this total, with *coarse cereals* and *pulses* respectively contributing 1 and 2 per cent. For *rice,* of the 1971-91 production increment (Table 6) of 43 Mt / an, 62 per cent came from smaller farms (< 2.0 ha), with

Table 5: Rice and wheat: contributions to total food-grains production: 1971 and 1991

Crop	Production (M ton / an)		Production increment 1971-1991	
	1971	1991	M ton / an	% of total
Rice	43	86	43	47
Wheat	24	70	46	50
Coarse cereals	30	31	1	1
Pulses	12	14	2	2
Total	109	201	92	100

Source: Ministry of Agriculture, GOI.

Table 6: Contribution (%) to incremental production (rice and wheat): Various farm-size categories: 1971-91

Crop	Farm-size group	1971-81	1981-91	1971-91
Rice	Sub-marginal	16	16	16
	Marginal	18	21	20
	Small	25	26	26
	Subtotal < 2.0 ha	59	63	62
	Medium	27	24	25
	Large	14	12	13
Wheat	Sub-marginal	11	11	11
	Marginal	13	16	15
	Small	19	24	22
	Subtotal < 2.0 ha	43	51	48
	Medium	27	23	25
	Large	30	26	27

Source: Adapted from Agriculture Census Reports.

25 per cent from the medium-size farms, and 13 per cent from the large farms. For *wheat,* 48 per cent of the production increment (46 million tons) came from the smaller holdings, 25 per cent from the medium-size, and 27 per cent from the large farms.

The results from these Tables 3, 4, 6 thus attest to the impressive role of small-holders in the Green-Revolution process and in the attainment of national food security. Moreover, in preparing those Tables it was assumed (lacking other evidence) that yields were *equal* among all farm-size categories. If, as is suggested later in this analysis, smaller farms have *higher* productivity than larger ones, then estimates for the proportionate contributions from the smaller holdings shall correspondingly increase. It appears, therefore, that in the national interest the small-holder role should be further strengthened. Such strengthening could facilitate higher productivity, stability, and sustainability of agricultural production, and hence help address - at both household and at national levels - the emerging issues of equity in nutritional security and in food security.

IV. AGRICULTURAL DIVERSIFICATION ON SMALL FARMS

Agricultural diversification is an important mechanism for economic growth. It depends, however, on there being opportunities for diversification and on farmers' responsiveness to those opportunities. Agricultural diversification can be facilitated by technological breaks-through, by changes in consumer demand or in government policy or in trade arrangements, and by development of irrigation, roads, and other infrastructures. Conversely, it can be impeded by risks in markets and prices and in crop-management practices, by degradation of natural resources, and by conflicting socio-economic requirements - perhaps for employment generation, or for self-sufficiency or foreign-exchange-earning capacity in particular crops or livestock or fishery or forest products.

Table 7 quantifies the proportional changes between 1971 and 1991 in the land area allocated among various crops on farms of various sizes. These changes permit some interpretations of trends in crop intensification and farm-system diversification - however, since an appreciable fraction of these changes derived from the re-distributions (Table 2, final column) of land from larger to smaller farms, the interpretations concerning intensification and diversification are highly tentative. (Such interpretations are nonetheless attempted, recognizing that intensification and diversification have been expressly promoted by government policies and facilitated by improved technologies.).

Table 7: Area allocated among specific crops: Proportional (%) change 1971 to 1991 for farms in various size categories

Crop	Sub-marginal	Marginal	Small	Medium	Large	All
Rice	93	64	38	23	-16	21
Wheat	141	110	83	48	- 3	35
Other cereals	23	32	35	14	-38	-15
Pulses	2	10	-	-10	-38	-25
Oilseed	160	112	121	103	19	54
Fruit/V'g't'ble	155	168	152	132	49	111
Sugarcane	162	179	123	71	1	62
Cotton	169	174	170	79	-28	4
Jute	143	83	10	-10	-45	10
Fodder	1615	1181	892	583	378	471

Source: Computed from Agricultural Census 1970-71 and 1990-91

The implication of the numbers in Table 7 is best appreciated by comparing them with the corresponding proportionate increases in net cropped area (Table 2, final column: values respectively of + 81, + 65, + 49, + 28, and - 25 %, for sub-marginal, marginal, small, medium, and large farms). Thus for *marginal* farms, Table-7 entries exceeding + 65 % would indicate an *intensification* in the land allocation to the particular crop; correspondingly, values less than + 65 % would indicate a decreased land allocation. By this analysis, we thus determine that the small- and medium-size farms (in aggregate) *increased* their proportionate allocations to wheat, to oil-seeds, fruits / vegetables,

sugarcane, cotton, and fodder; they *decreased* their allocations to rice, cereals other than rice and wheat, pulses and jute. On the marginal and sub-marginal farms (considered in aggregate), there were seemingly increased proportionate allocations to wheat, to oil-seeds, to fruits / vegetables, sugarcane, cotton, jute, and fodder; they *decreased* their allocations to cereals other than rice and wheat, and to pulses, and maintained (or increased very slightly) their allocations to rice. *[We must here caution that it seems implausible that, for a particular farm-size category, all - or nearly all - entries could exceed their corresponding proportionate increase in net cropped area. It is nonetheless striking that for all farms - including the largest - there was during 1971-1991 a very considerably-increased allocation to fodder crops (facilitating a "livestock revolution") and a nutritionally-worrisome decrease in allocations to pulses.]*

The preceding caution notwithstanding, Table 7 might nonetheless permit (in addition to the foregoing consideration of *intensification*) some indication of trend in *farm-system diversification*. If, for each category of farm size, the number of crops for which the Table-7 entry is *less than* the Table- 2-final-column value is subtracted from the number of crops for which the Table-7 entry *exceeds* that Table- 2 value, then the *net* figure might serve as a proxy for the trend in on-farm diversity. For the categories sub-marginal, marginal, small, medium, and large, that net figure is respectively 6, 4, 2, 2, and 2: perhaps indicating that compared to the larger farms, the smallest ones have found it more necessary - or/and more profitable - to diversify.

Indeed, on small farms the cropping pattern is determined by household-food needs, and food crops thus occupy four-fifths of the cropped area (Jha, 2001). Also on the small farms, larger proportionate allocations (compared to larger farms) can be made to the labour-intensive crops (fruits, vegetables, sugarcane, cotton, jute). The National Sample Survey (48th Round) indicates that on small farms most of the fruit and vegetable area is in the homesteads. Similarly - though small farms can accommodate rather few animals per household - more of the aggregate (national) livestock herd is housed on the small farms than on the large ones. These features have implication for intensification and commercialisation of small-farm and rural enterprises.

As a supplement to the Table-7-derived analysis of farm-size influence on crop diversification, values and trends for the Simpson Index of diversity (for all farms, and separately for irrigated and non-irrigated farms) are presented in Tables 8 and 9. For all farms (whether irrigated or not, Table 8) and in all three censuses (1971, 1981, 1991), diversification is highest (19 - 21) on sub-marginal farms, and least (8 - 9) on the largest farms. [This finding confirms the tentative diversification-related conclusions from Table 7. Small-holder farmers can make frequent changes in crop choices in order to utilize their family labour and to increase their income.] Table 8 suggests that the availability of *irrigation* increases very considerably the options for diversification: thus, for all farm sizes (in aggregate) and for each census date, diversification index is much higher (at 22 - 23) for irrigated farms than for non-irrigated ones (8 - 9). For all farms (whether irrigated or not), the diversification index was effectively unchanged between 1971 and 1991 - this conclusion differs from that tentatively derived *via* Table 7; this Table-8 conclusion is the more-reliable. The importance of quantifying diversification (and its trend) is that encouragement of on-farm diversification is seen as a workable development strategy wherewith to address the objectives of output growth, employment generation, and natural-resources' sustainability.

Table 8: Simpson Index of cropping-pattern diversity : Various years and farm sizes: Irrigated and non-irrigated

Farm size	Irrigated farms			Non-irrigated farms			All farms		
	1971	1981	1991	1971	1981	1991	1971	1981	1991
Sub-marginal	29	31	29	16	18	18	19	21	21
Marginal	29	30	27	15	16	15	18	19	18
Small	26	28	24	13	14	12	15	16	14
Medium	24	23	21	11	11	10	12	12	11
Large	19	20	19	9	9	8	9	9	8
All farms	22	23	22	9	10	9	10	11	11

Source: Computed from cropping-pattern data, Agricultural Census 1970-1, 1980-1, 1990-1, GOI.

Notwithstanding that Table 8 indicated minimal changes in the Simpson Index of Diversity during 1971-1991, there were during those two decades substantial changes in the *actual crop choices* that farmers made (albeit without changing the extent of their farm diversity). These changes are represented (Table 9) by the percentage of the farm area (for each category of farm size, and distinguishing between irrigated and non-irrigated and between decades 1971-81 and 1981-1991) for which changes of crops were made. Aggregated for all farm sizes, and averaging over the two decades, changes were more extensive - occurring on 16 - 17 per cent of the area - on irrigated lands: contrasting with only 9 - 10 per cent on non-irrigated lands. Compared to the Simpson Index (Table-8) tabulation, this Table-9 compilation indicates more strongly an effect of farm size, and also of irrigation. Thus, *with irrigation,* and within *sub-marginal* holdings, 27 per cent of the land area experienced crop changes during 1971-81 (compared to 13 per cent on *large* farms) - and 23 per cent during 1981-91 (whereas only 10 percent on large farms); however, *without irrigation,* farm size had minimal influence in either decade.

Table 9: Percentage of land (in various farm-size categories) on which crop-sequence was changed: 1971-1981 and 1981-1991: Irrigated and non-irrigated

Farm size	Irrigated farms		Non-irrigated farms		All farms	
	1971-81	1981-91	1971-81	1981-91	1971-81	1981-91
Sub-marginal	27	23	14	12	19	16
Marginal	22	24	11	13	14	17
Small	20	21	10	14	12	16
Medium	18	16	10	10	11	11
Large	13	10	15	16	11	13
All farms	17	16	9	10	9	10

Source: Computed from cropping-pattern data, Agricultural Census 1970-1, 1980-1, 1990-1, GOI.

Other data from the agricultural censuses, and various regional micro-scale studies, similarly demonstrate that smaller (< 2.0-ha) farms do practise diversified farming. On quite small holdings - often fragmented - farmers nation-wide allocate their land among seasonal crops, fruits, and vegetables, dairy cattle, and perhaps poultry to maximize their household-labour utilization and income.

It is recognized that agricultural diversification helps achieve food security and improved human nutrition and increased rural employment; it can also impact favourably on soil fertility and pest incidence. India's agro-climatic regional planning has documented the zones of maximal opportunity for diversified agriculture on smaller farms. Planning (at local and regional scales) to utilize those opportunities - and to provide the supportive agro-processing and market and communications facilities - must involve farmers' representatives and cooperatives, administrators, extensionists, researchers, inputs suppliers (public and private), and NGO's; it must address on-farm and non-farm features.

V. INPUTS FOR SMALL-HOLDINGS: IMPACTS ON FOOD SECURITY AND POVERTY ALLEVIATION

Irrigation:

For the various farm-size groups and for the three census years, Table 10 lists the proportion of net sown area that has benefit of irrigation, and lists also the multiple-cropping intensity. At each census date, irrigation coverage and cropping intensity were appreciably higher for small-holdings than for large farms. The proportion of land that was irrigated among the sub-marginal holdings increased from 35 per cent in 1971 to 43 per cent in 1991; corresponding figures for large farms were 16 per cent and 25 per cent; it is thus apparent that the proportionate increase in irrigation facility was substantially higher on large holdings (x 1.56, = 25 / 16) than on the sub-marginal ones (x 1.23). Aggregated over all farm-size groups, the percentage of net sown area that was irrigated progressed from 20 to 25 to 30 during 1971-1981-1991. During the 1990s, expansion of irrigation has been less rapid than during the 1970s and 1980s, and the rate of expansion continues to decline.

Table 10: Irrigation (areal extent) and cropping intensity: Various years and farm sizes

Farm size	Irrigation (% of net sown area)			Cropping intensity		
	1971	1981	1991	1971	1981	1991
Sub-marginal	35	40	43	134	135	147
Marginal	31	36	39	128	133	138
Small	26	31	33	122	125	130
Medium	24	27	31	119	125	128
Large	16	19	25	112	117	122
All farms	20	25	30	116	122	128

Source: Computed from Agricultural Census 1970-71, 1980-81 and 1990-91, GOI

Table 11: Percentage of irrigation area serviced from various sources: Various years and farm sizes

Farm size	Canal		Tank		Well		Tube-well		Other	
	1971	1991	1971	1991	1971	1991	1971	1991	1971	1991
Sub-marginal	39	35	18	11	19	9	16	36	8	9
Marginal	41	35	16	9	19	12	15	35	8	9
Small	42	34	14	8	21	18	16	33	8	8
Medium	41	33	12	6	22	21	18	32	7	7
Large	43	35	10	4	25	26	17	30	5	6
All farms	42	34	12	6	23	20	17	32	7	7

Source: Agricultural Census, 1970-71, and 1990-91, GOI

Table 11 summarizes - for the various farm-size categories - the sources of irrigation (as percentage of area serviced) at the census years 1971 and 1991. Changes between those

two surveys can reveal what types of water sources were developed to generate the achieved increases in irrigation-water supply. Aggregated over all farm sizes, the preponderant change is the almost doubling in the proportion of water supplied by tube-wells; correspondingly, the proportion supplied by other sources (and notably by canals and tanks) decreased substantially. In absolute terms, more than three-fourths of the 1971-91 increase in irrigated area resulted from expansion of supplies from tube-wells and from other minor sources. Among farm-size categories, and at 1991, the proportion of land irrigated by canals or by tube-wells was roughly equal (30 - 35 %) for all categories. Irrigation from wells was about three times more prevalent on the largest than on the smallest holdings.

Table 12 lists - by farm-size group and for 1991 - the extents (absolute and proportional) of irrigated and of non-irrigated land. The small and the marginal (here subsuming the sub-marginal) holdings have a higher proportion of their land irrigated as compared to the medium- and large-size holdings. Thus, from a total of about 107 million hectare (Mha) of *non-irrigated* land, the marginal and small holdings together commanded about 34 per cent; but from a total of about 63 Mha of *irrigated* land those smaller holdings commanded almost 42 per cent. Conversely, while the large farms had a 42 per cent share of the *non-irrigated* land, they had a lesser share - only 35 per cent - of the *irrigated* land.

Table 12: Gross cropped area (million ha), and proportion (%), irrigated or non-irrigated: various farm-size categories, at 1991.

Farm-size group	Gross cropped area (million ha)		Gross cropped area (percent share)	
	Irrigated	Non-irrigated	Irrigated	Non-irrigated
Marginal	13.0	16.4	20.6	15.3
Small	13.3	20.1	21.0	18.8
Medium	14.8	25.7	23.4	24.1
Large	22.1	44.7	35.0	41.8
Total	63.2	106.9	100.0	100.0

Source: Agricultural Census 1990-91, GOI

Note: The Marginal Group here subsumes the Sub-marginal Group, and thus includes all holdings smaller than 1.00 ha.

The proportionately higher availability of irrigated land among the smaller-size farms suggests that such farms are well-positioned to benefit from new agricultural technologies, and hence to raise their productivity and income, and to strengthen household and national food security.

Moreover, the non-irrigated ("rainfed") lands not only have lesser productivity than the irrigated lands, but they also are the location for the (proportionately) greater concentrations of poor and hungry persons. It is thus highly relevant that the data of Table 13 suggest that even a small availability of irrigation (perhaps sufficient to irrigate one-fifth of the farm area) can help lessen rural hunger and poverty. Those data

Table 13: Irrigation availability, and rural poverty and hunger: Various farm sizes, and at 1983 and 1993 (Rural India only)

Farm-size group	Irrigated area (per cent)	Percentage of population			
		Poor		Under-nourished	
		1983	1993	1983	1993
Sub-marginal	0	56	40	51	37
	<20	61	27	34	20
	20-50	54	36	34	29
	50-80	50	36	35	28
	>80	52	37	36	27
Marginal	0	49	32	37	31
	<20	49	26	29	25
	20-50	44	25	26	27
	50-80	44	23	24	16
	>80	41	22	25	15
Small	0	45	27	32	27
	<20	43	22	27	22
	20-50	41	20	21	22
	50-80	36	18	17	13
	>80	32	12	17	9
Medium	0	45	24	27	20
	<20	34	18	21	17
	20-50	29	15	18	11
	50-80	27	9	14	8
	>80	23	9	15	8
Large	0	35	18	20	12
	<20	25	13	14	14
	20-50	20	10	12	15
	50-80	16	16	15	12
	>80	13	8	11	7

Source: Computed from household data in the National Sample Survey (38th and 50th Rounds).

indicate that regardless of farm size or of irrigation availability there were substantial decreases in both poverty and under-nourishment during 1983 - 1993: these decreases derived from factors other than irrigation availability. Data from the more-recent (1993) survey suggest that (excepting possibly the largest and the sub-marginal farms)

both poverty and (to a lesser extent) *under-nourishment* were progressively lessened as the availability of irrigation increased. For the large farms, irrigation was seemingly effective in lessening poverty, but its effect on under-nourishment is less certain; for the sub-marginal holdings, the data for the smallest (< 20 %) irrigation category are seemingly aberrant and defy any interpretation.

Nonetheless, it seems plausible that regardless of farm size the availability of *any* irrigation - particularly during water-short interludes occurring at critical growth stages - is undoubtedly helpful for farms that otherwise are rain-fed only. There is thus confirmation of the appropriateness of government programmes for watershed development and - where water is available - for water-conserving technologies such as drip and sprinkler irrigation.

Moreover, the Table-13 data suggest that provision of irrigation to currently non-irrigated areas will be more beneficial than the provision of additional water to lands that already are irrigated - and for which additional water may indeed bring environmental risk. This feature is germane to the development of effective water policies (with institutional supports) that will facilitate judicious and equitable allocation and distribution of water - and utilization of water resources - in such manner as to assist the currently non-irrigated small-holder ecozones and the poor and hungry persons dependent upon them.

Fertilizers and Pesticides:

The increases in agricultural production and productivity during the Green Revolution resulted from the conjunctive use of modern cultivars, irrigation, and fertilizers and other agro-chemicals. For the agro-chemical inputs, a 1991-92 follow-up survey to the 1990-91 census indicates (Table 14) that 87 % of irrigated holdings - regardless of size - received manufactured fertilizer; of the non-irrigated farms 46 % - though somewhat less on the largest farms - received such fertilizers. Farm-yard manure applications were on average slightly more prevalent (35 %) on irrigated farms than on non-irrigated (29 %); however, with or without irrigation, applications were more prevalent on small-holdings

Table 14: Proportion (%) of land area receiving manufactured fertiliser, farm-yard manure, and pesticides (all crops, 1991-2): Irrigated and non-irrigated: Various farm sizes

Farm-size group	Manufactured fertiliser		Farm-yard manure		Pesticides	
	Irrigated	Non-irrig.	Irrigated	Non-irrig.	Irrigated	Non-irrig.
Marginal	86.8	45.2	40.4	34.0	24.7	8.3
Small	85.2	47.6	42.0	34.3	27.4	11.5
Medium	87.4	45.7	34.4	31.4	33.1	11.8
Large	87.3	37.8	26.9	23.9	38.6	10.3
All farms	86.8	42.7	34.6	29.2	32.1	10.6

Source: Input Survey 1991-92, GOI.

Note: The Marginal Group here subsumes the Sub-marginal Group, and thus includes all holdings smaller than 1.00 ha.

than on larger farms. Conversely, pesticides usage increased with farm size - particularly for irrigated farms; and applications were much more prevalent on irrigated farms (39% on average) than on non-irrigated (10%).

Table 15 specifies the *rates* of application of fertilizer nutrients and of farm-yard manure (each per hectare per year, for all crops) at 1991-2. Rates on irrigated farms (irrespective of farm size) were about 112 kg / ha.ann, and on non-irrigated farms between 20 - 40 kg / ha.ann - with application rate decreasing as farm-size increased. Farm-yard manure applications were on average nearly three times larger on irrigated than on non-irrigated lands; significantly, they were two-top-three times larger on marginal holdings than on large farms.

Table 15: Fertilizer nutrients and farmyard manure: Application rate (kg/ha.ann): All crops, 1991-2: Irrigated and non-irrigated: Various farm sizes

Farm size	Manufactured fertilizer		Farm-yard manure	
	Irrigated	Non-irrigated	Irrigated	Non-irrigated
Marginal	112.6	39.9	3 772	1 596
Small	109.3	36.5	3 162	1 220
Medium	114.2	31.6	2 248	955
Large	111.2	23.9	1 963	576
All farms	111.7	30.6	2 588	945

Source: Input Survey 1991-92, GOI.

Note: The Marginal Group here subsumes the Sub-marginal Group, and thus includes all holdings smaller than 1.00 ha.

The proportionate (all-India) allocations of fertilizers and manures among various crops (as at 1991/92) are recorded in Table 16. The largest allocations (by far) are to rice and wheat. Among farm-size groups, the small, marginal, and sub-marginal holdings (in aggregate) - and who (Table 1) command only 33 per cent of the net cropped area - nonetheless purchased and used (at 1991/92) as much as 42 per cent of the total of manufactured fertilizers and 54 per cent of all farm-yard manure. In contrast, the large- and medium-size holdings (in aggregate) - who command 67 per cent of the net cropped area - used only 58 per cent of the fertilizer and only 46 per cent of the farm-yard manure. Despite their constrained resources (including their constrained access to micro-credit) and their greater vulnerability to adverse happenings, the small-holding farmers - and contrary to some perceptions - use farm inputs to a proportionately greater extent than the large-holding farmers.

The small-holders' preponderant utilization of farm-yard manure - in particular - has favourable implication for sustainable agriculture and sustainable natural-resource management. Recognizing also that small-holders allocate proportionately more of their resources to rice and wheat (India's two main staples), their contribution to national grain production is correspondingly important. These findings and observations are highly relevant to national considerations - within the confines of international obligations - of policies for fertilizer prices and subsidies and for national food security and for the alleviation of rural poverty.

Technically - and impinging on national agricultural-extension policy - a crucial issue is to raise on-farm fertilizer-use efficiency such that crop-nutrients management is viable and profitable without need of subsidies. India has much knowledge and expertise pertaining to efficient fertilizer practices - including balanced (and soil-test-guided) and appropriately-timed and placed applications of major nutrients and (where needed) of micro-nutrients, soil amendments, and foliar-applied fertilizers. Location-specific application of this knowledge and expertise can be facilitated through coordinated action by the agricultural extension system, the fertilizer manufacturers and distributors, and the (private-sector) local dealers. The private-sector dealers are a major source of information to farmers; it is thus in the national interest that existing (public-sector) programmes of training for such dealers should be strengthened and expanded.

Table 16: Proportional allocation (%, to various crops and to various farm sizes) of fertilizer nutrients (N+P+K) and of farmyard manure: 1991-92: Irrigated and non-irrigated lands in aggregate

Crop or farm size	Allocation of manufactured nutrients (%)	Allocation of farm-yard manure (%)
Rice	35.1	46.7
Jowar	3.6	2.5
Bajra	1.4	3.1
Maize	2.6	3.5
Ragi	1.0	2.4
Wheat	19.3	16.2
Gram	0.6	0.3
Arhar	0.8	0.8
Sugarcane	5.5	3.5
Groundnut	4.7	5.6
Rape/mustard	1.5	1.0
Cotton	5.9	2.0
Jute	0.3	0.1
Farm-size group		
Marginal	20.6	28.5
Small	21.1	25.1
Medium	24.2	21.8
Large	34.1	24.6

Source: Input Survey 1991-92, GOI.

Note: The Marginal Group here subsumes the Sub-marginal Group, and thus includes all holdings smaller than 1.00 ha.

Implements and Machinery:

Farm implements, machinery, and draught animals (especially if *owned* by the farm household) can increase substantially on-farm resource-use efficiency and labour productivity. Table 17 specifies the numbers of ploughs, irrigation-pump sets, and tractors *used* (not necessarily owned) on holdings of various sizes at 1991-92; data are presented on the bases of *per thousand holdings* and *per 1000 hectare of holdings.* Predictably, the usage of implements / machines per holding was much higher on large holdings than on the marginal (including sub-marginal) and small holdings. Conversely, the usage *per hectare* was for each type of implement / machine substantially higher on smaller than on larger holdings - indicating that even the smallest holdings had effective access to tools and machinery. However, many of the smaller holdings depended on other households / farms for some of their mechanized operations.

Table 17. Implements and machinery *used* (at 1991-92) on farms of various sizes

Implement / Farm size	Marginal	Small	Medium	Large	All farms
Number per 1000 holdings					
Plough	583	957	1 193	1 745	845
Pump-set	87	208	255	417	164
Tractor	25	38	47	113	38
Number per 1000 ha of holdings					
Plough	1 371	674	436	225	531
Pump-set	204	146	93	54	103
Tractor	58	27	17	15	24

Source: Input Survey 1991-92, GOI.

Notes: *Use* of equipment / machinery does not imply *ownership*.
The Marginal Group here subsumes the Sub-marginal Group, and thus includes all holdings smaller than 1.00 ha.

Draught power for mechanized operations may be provided by animals or by tractors. Table 18 summarizes the availability (at 1993-94) of draught *animals* on farms of various sizes. Two-thirds of sub-marginal-farm households did not own even one draught animal. Moreover, one-half of *all* households (when aggregated for all farm sizes) did not own a draught animal. However, among those households which had large or medium-size holdings but which are listed as having no draught animal, some may well have possessed one or more tractors. Some of those tractors may have been (and may still be) available by hire / contract to sub-marginal and to marginal farmers for land-preparation and other operations.

Thus, and recognizing that many draught operations rely on a *yoked pair* of animals, those sub-marginal and marginal holdings that own either one (only) or no draught animal merit special attention. Such holdings / farmers may depend on the owners of large or of medium-size holdings to undertake operations (notably land preparation) through hire arrangements - when the animals can be made available. Operations on the

smaller holdings may thus be delayed pending such availability - with detriment to overall productivity. The strengthening of custom-hire services (public or private sector) - to optimize the use of temporarily-available draught animals and tractors and operators - might thus be a mechanism through which crop productivity could be raised both locally and nationally.

Table 18: Proportion of holdings *owning* no, one, or more draught animals: 1993-94: Various farm-size categories

Farm-size category	Ownership of draught animals [as proportion (%) of holdings]		
	None	One	Two or more
Sub-marginal	64	11	25
Marginal	44	11	45
Small	36	11	59
Medium	30	11	59
Large	24	10	66
All farms	50	11	39

Source: Computed from household data in the National Sample Survey (50th Round - 1993-94): All-India survey on consumer expenditure, employment, and unemployment.

Table 19 explores (at 1993-94, and for various farm-size groups) the relation of livestock ownership to human poverty, intensity of hunger, and nutritionally-balanced diet. Poverty and hunger - particularly among the households farming sub-marginal- and marginal-sized holdings - were lessened appreciably by the ownership of a buffalo, but somewhat less by the ownership of a milch cow. For *all* sizes of holdings, the incidence of *poverty* and of *under-nourishment* were less by about one-half (compared to the no-livestock situation) on those holdings that owned a buffalo or of a buffalo and a cow. Similarly, and for all categories of farm size, the *quality of diet* was improved - to the extent of a one-tenth decrease in the dietary-energy dependence on cereals - by the ownership of a buffalo or of a buffalo and a cow.

The estimation of *food deficit* (or intensity of hunger) for those arbitrarily defined as under-nourished (Table 19) is correspondingly arbitrary and perhaps suspect. Nonetheless, it does appear that for all categories of holding the ownership of a buffalo lessens the estimated food deficit of under-nourished persons by about one-fifth. (The data, however, seem aberrant if not perverse in suggesting that the ownership of a cow, in addition to a buffalo, *increases* - appreciably - the intensity of hunger.)

Financially - and with significance for short-term poverty and hunger - inter-year fluctuation in income is lessened when livestock comprise part of the farm system. Thus, Kumar and Mittal (2000) suggest that livestock are in India favoured as an income-generating enterprise. Indeed, Birthal *et al* (1999) report that total factor productivity in the Indian livestock sector increased at 1.8 % / ann during 1981-1996 compared to only 1.0 % / ann in the crop sector. There is thus full justification to strengthen and expand - as a component of the public- and private-sector efforts to lessen poverty and hunger -

ongoing programmes that support livestock production and enterprise. Priorities might be to increase efforts that address the identified constraints and knowledge gaps in livestock genetics, health, and nutrition.

Table 19: Livestock ownership: Relations to human poverty, hunger, and nutritional balance: Rural India: 1993-94: Various farm-size categories

Farm-size category	Livestock type	Per cent of human population		Food deficit of under-n'rish'd (kcal/cap.d)	Cereals in energy intake (%)
		Poor	Under-nourished		
Sub-marginal	None	42	40	325	78
	Cow	37	28	285	76
	Buffalo	30	22	276	71
	Cow and buffalo	30	21	286	70
Marginal	None	33	32	307	77
	Cow	28	23	272	76
	Buffalo	21	17	232	69
	Cow and buffalo	20	15	275	69
Small	None	24	25	302	75
	Cow	23	21	279	74
	Buffalo	14	12	236	66
	Cow and buffalo	14	13	227	67
Medium	None	22	15	271	71
	Cow	22	17	265	73
	Buffalo	11	10	204	64
	Cow and buffalo	8	9	255	64
Large	None	24	17	243	71
	Cow	24	19	284	71
	Buffalo	9	10	183	66
	Cow and buffalo	8	8	263	66

Source: Computed from household data in the National Sample Survey (50^{th} Round - 1993-94).

Notably, the data of Table 19 highlight the contributions (at 1993-94) of *buffalos* in lessening rural poverty and hunger and in improving diets (through milk supply). Fortunately, in India (as throughout South Asia, and in contrast to East Asia) buffalo populations increased throughout the 1990s. However, even in India - where the buffalo population now approaches 100 million - efforts to improve buffalo stocks and productivity have been much less than would be justified by those Table-19 analyses. Increased attention to this national asset - particularly to the constraints in breeding and in reproduction - could be highly cost-effective, both economically and socially.

VI. AGRICULTURAL GROWTH AND TOTAL FACTOR PRODUCTIVITY

Agriculture - world-wide - is a vital determinant of the livelihoods of small-holder farmers and rural communities. Agricultural growth - throughout global history - has been the pro-genitor of broad-based economic growth and development, as linkages between farm- and non-farm economies generated widely-based employment, income, and growth. Agricultural growth shall thus in the *future also* be the *sine qua non* for alleviation and eradication of rural poverty and hunger in those countries that have not yet fully achieved their broad-based growth. This is particularly so in India, where the numbers of rural poor - including the land-less and those farming sub-marginal holdings - are so large. Moreover, the smallness of many of the Indian farm holdings, and the low income elasticity and high price elasticity of cereals, together dictate that future agricultural growth shall need to diversify beyond its current cereals emphasis.

However, new analyses of India's agricultural growth during 1970-2001 give cause for concern - perhaps for alarm. For all cereals - in aggregate - the annual growth rate in *production* during the six-year segments 1970-76, 1976-82, 1982-88, 1988-1994, 1994-2000 was respectively 2.5, 2.5, 3.0, 2.6, and 1.8 % / ann. Corresponding analyses for the index of *total* agricultural production show a similar pattern, with the growth rate for 1994-2000 attaining only 1.5 % / ann.

Thus in the late 1990s, the growth rates, though creditable, are lower than at any time since 1960. These declines may constitute in part a response to diminishing demand and to inadequate returns to farmers: globally, the Year-2001 world prices for rice, oil-seeds, and livestock were the lowest since 1998; and in India, the strategic buffers were fully stocked. However, for cereals, the 1994-2000 growth rate for *yield* - at 1.7 % / ann, and much below the 1982-1994 average of 3.5 % / ann - causes further anxiety. This slackening in yield growth rate may result from several causes: from a lessening of inputs as farmers respond to falling prices, or from non-increase in inputs where farmers have already optimized their inputs applications, and from some progressive closing of yield gaps in some states. Previous analyses (Kumar, 1998) had correspondingly observed a lessening in the growth of total factor productivity (TFP - which quantifies technological contributions) from 1.5-2.0 % / ann in the 1970s and 1980s to 1.0 % / ann in the 1990s. Moreover, this cereals-yield growth slackening has been compounded by the slight decline in *cereals area* (averaging - 0.1 % / ann) since the early 1980s.

The foregoing 1994-2000 growth rates for various entities (at 1.8 % / ann, 1.5 % / ann, 1.7 % / ann) are only marginally higher than the forecast human-population growth rate (1996-2010) of 1.3 % / ann. Moreover, a projection of the 1988-2000 trends suggests that those various growth rates may indeed fall below 1.3 % / ann during 2001-2004. The latest (early-2002) statistics for all-cereals production suggest that during 1997-2001 the growth rate had indeed decreased to approximately 1.3 % / ann. A low rate of future agricultural growth - particularly if below the human-population growth rate - would have adverse consequence for *employment* generation and for lessening of *poverty*.

These recent analyses give results that are consistent with those derived from earlier data-sets. Thus Bhalla (2001) noted that the annual growth rate of Agricultural Gross Domestic Product (AGDP) declined from 3.2 % / ann during 1981-91 to 1.9 % / ann during 1991-1999. Corresponding figures for the *crops-sector* AGDP were 3.5 % / ann and 2.4 % / ann, and for the crops-sector *production* 2.6 % / ann and 1.4 % / ann. *Yield*

growth rates similarly decreased between the 1980s and the 1990s: for *rice* from 3.2 to 1.3 % / ann, for *wheat* from 3.1 to 1.3 % / ann, and for *cotton* (dramatically) from 4.1 to 0.6 % / ann.

These crucial growth-rate estimates - as of poverty and under-nourishment, and of yield, productivity, and production in the several agricultural sectors - derive from time-trend analyses. There can be additional insights and more-dependable near-term forecasts if such analyses are conducted not only using ten-year-length time-segments (as is general practice) but also using six-year-length segments. Compared to analyses based on ten-year segments, those based on six-year segments have an imprecision that is typically larger by somewhat less than one third. This disadvantage is perhaps more than compensated by the larger member of estimates (segments) where-from to assess the time trends, and by the increased relevance - for near-term forecasts - of the later estimates in those time-trend series.

Kumar and Mittal (2000) quantified the proportional contribution of *crop area* to production. During 1967-1981, the partial contributions to production growth were: yield 48 per cent, area 21 percent, cropping pattern 20 percent, and interactions 11 percent. At 1982-96 the corresponding proportions were 57, 8, 22, and 13 percent. The contribution of yield has thus *increased* as that of area has *decreased*. The increased contributions from "cropping pattern" and from "interactions" may represent increases in production efficiency that result from research and technology transfer.

Growth (or decline) in total factor productivity (TFP) results predominantly from public investment (or lack of investment) in infrastructures (irrigation, electricity, roads) and in agricultural research and extension, and from efficient use of water and plant nutrients. The observed decreases in the rate of increase of TFP are in large part a consequence of a substantial lessening of investments - notably public-sector investments - in India's agriculture. Indeed, India's government expenditures during the 1990s for agriculture per agricultural worker have been the lowest in South Asia, and indeed below those of Sub-Saharan Africa.

It is well recognized that future increases in agricultural production (crops, livestock, fisheries, forests) must accrue essentially through increased production per unit land area. There is consequent requirement to strengthen the resources wherewith the farmers, foresters, and fisher-folk can raise their production efficiency and hence their total factor productivity (TFP).

Investment in these agricultural resources must therefore be increased, and must be directed along those avenues that are known to increase productivity: to the infrastructures and to the research-extension-farmer-market system. Particularly, investments - including investments in location-specific research / extension - should address those regions where current productivity is low and the potential for sustainable increase is high.

The benefits of increasing TFP are felt nation-wide: costs of production decrease, and prices fall and stabilize. Producers and consumers both gain. Decreased food prices preferentially benefit the poor (whether urban or rural), since the poor spend proportionately much more of their income on food (particularly cereals). Lower prices

of home-produced agricultural products will also assist India's agriculture to accommodate to the globalization of agricultural trade.

For the families operating marginal-size farms and for the rural poor, low productivity constitutes a major constraint as those rural families strive to achieve household food security. Investments and efforts to improve and sustain small-farm productivity are therefore vital. A synergistic blend of traditional and modern knowledge, tools, and technologies - "the eco-technology" - should be mobilized to assist small-holder households (Pinstrup-Andersen, 2000). Similarly, research, technology development, and extension programmes should strengthen those of their activities that target the needs and opportunities of small-holders - including women small-holders.

It is thus encouraging to report - and to counter common mis-perception - that for crops that are important to non-irrigated small-holdings there *has* in recent years been technological progress. Notable amongst these crops are the coarse cereals and the pulses, and also the oilseeds, fibres, and vegetables. Analyses (FAO/RAP, 2001) for eighteen major crops (irrigated and non-irrigated) and for several states (here summarized in Appendix Table 2) showed positive TFP growth for all eighteen of those crops - including those non-irrigated - though not necessarily in every state. The analyses correspondingly identify those crops and states where remedial research / extension action is warranted.

Developments and investments that lead to growth in total factor productivity are likely also to lead to poverty reduction. Appendix-Table 3 summarizes analyses for fourteen states in which *poverty decreased* during 1973-98 at rates ranging from 2.2 to 5.9 % / ann. In all of those states, one or more of the major crops exhibited positive TFP growth. In Andhra Pradesh and Punjab - in each of which poverty decreased at 5.9 % / ann, TFP growth was notably positive for rice, sorghum, and groundnut (Andhra Pradesh) and for rice and wheat (Punjab). Policies and investments that increase TFP are thus highly likely to lessen rural poverty and hunger.

Such policies and investments should consolidate and expand the ongoing programmes - including their location-specific research / extension components - to assist the non-irrigated and the dry-land areas. High returns may be expected for investments in physical and institutional infrastructures, in inputs-supplies facilities (quality seeds and agro-chemicals), in watershed management, small-scale mechanization, hybrid cultivars, and soil-testing services.

Additionally, *literacy* - and *numeracy* - bring appreciable benefit to farm productivity and modernization. Literacy correlates strongly (Kumar and Mittal, 2000) with the adoption of cultivars, nutrients management, and mechanization, and with productivity. Increased literacy may thus be expected to generate increases in agricultural productivity and hence in household and in national food supplies. Increasingly, India's future agriculture will be science-led and will require sound economic management; there would consequently be high return to investment in rural education - for males and for females.

VII. NUTRITION AND POVERTY: SMALL-HOLDER FAMILIES

Food security implies not only the availability of basic foods, but also the accessibility to those foods and to basic nutritional elements. For rural India, Table 20 lists the energy intake (at 1993-94) from various foods by households having various farm sizes. Cereals comprise the dominant source of dietary energy on all sizes of farms: 75 per cent to households on sub-marginal holdings and 64 per cent on the large-farm households. Aggregated over all farms, cereals provided 72 per cent of dietary energy, 68 per cent of protein, and 17 per cent of fats. Milk and pulses together contributed about 20 per cent of protein intake.

Table 20: Calories, protein, and fats in rural-households diets: 1993-94: Various farm-size categories

Item		Sub-marginal	Marginal	Small	Medium	Large	All farms
Proportion (%) of calories, protein, and fat in total food intake							
Cereals	Calories	75	72	67	65	64	72
	Protein	70	68	66	65	64	68
	Fat	18	17	16	15	15	17
Pulses	Calories	4	4	5	5	6	4
	Protein	10	10	11	11	12	10
	Fat	2	2	2	2	2	2
Milk and products	Calories	5	7	10	12	12	7
	Protein	7	10	14	15	16	10
	Fat	29	35	41	43	44	35
Fats, oils	Calories	5	5	5	6	6	5
	Fat	41	38	34	33	32	37
Meat, fish, eggs	Calories	1	1	1	0	0	1
	Protein	5	4	3	2	2	4
	Fat	2	2	1	1	1	1
Veg't'ble	Calories	4	4	4	3	3	4
	Protein	5	5	4	3	3	5
	Fat	2	1	1	1	1	1
Fruits	Calories	1	1	1	1	1	1
	Fat	3	2	1	1	1	2
S'g'r, j'gry	Calories	4	5	6	6	7	5
Others	Calories	1	1	1	1	1	1
	Protein	2	2	2	2	3	2
	Fat	5	5	4	4	5	5
Average intake per person of calories (kcal/day), protein (gm/day), fat (gm/day)							
	Calories	2 096	2 262	2 442	2 597	2 695	2 253
	Protein	59	65	72	77	81	64
	Fat	28	33	43	50	54	34
Proportion (%)of non-cereal in total intake							
	Calories	25	28	33	35	36	28
	Protein	30	32	34	35	36	32
	Fat	82	83	84	85	85	83

Source: Computed from household data in the National Sample Survey (50th Round - 1993-94): All-India survey on consumer expenditure, employment, and unemployment.

Diet diversity increased with farm size. The Simpson Index of diet diversity was 0.43 for sub-marginal holdings, and 0.56 for large farms: large-farm households thus acquired their food energy from more diverse sources - consuming more pulses, milk, edible oil, and sugar. Crucially, calorie intake per person per day *decreased* as farm size decreased: 2 695 kcal / person.day for large-farm households, but only 2 096 for sub-marginal holdings. Similarly, protein intake on large-farm households (81 gm / person.day) was substantially higher than for sub-marginal-farm households (59 gm / person.day); and correspondingly for fats (54 compared to only 28 gm / person.day).

For all farm-size categories except the sub-marginal, the caloric and nutritional intakes met the minimum requirements. However, within each farm-size category there is substantial variation in food-energy and nutritional intakes - reflecting variations in resource availability and purchasing power; thus among households farming small, marginal, or sub-marginal holdings there may be appreciable under-nourishment.

Aspects of under-nourishment - and of poverty - are featured in Table 21, which lists the proportions (at 1983 and 1993) of food energy derived from the household's own farm. For all except the large farms (for which interpretation is difficult) *under-nourishment* decreased (at both 1993 and 1994) as the proportion of home-grown calories increased. Interpretations concerning poverty are more complex: provided the proportion of home-grown calories did not exceed 75 %, a higher proportion was associated with lesser poverty; however, households that perforce met from their own farm more than 75 % of their calorie needs were probably very poor, and lacked the resources wherewith to produce or to purchase the ingredients of a balanced diet.

Table 21 (as also Table 13) indicates that rural hunger and poverty were appreciably less prevalent at 1993 than at 1983. This encouraging feature resulted from various pro-poor and pro-hungry programmes and investments - including investments in human and rural development, and in on-farm and non-farm activities to increase productivity and rural incomes. Nonetheless (as itemized in Appendix Table 1), the number of rural poor and hungry - each about 150 million at 1998 - is substantial; moreover, their number represents about three-fifths of India's national total (rural and urban) of poor and hungry. From those 150 million, about 75 million depend on sub-marginal farm holdings (< 0.5 ha), and another 30 million on marginal holdings (0.5 - 1.0 ha). It is therefore appropriate that in national endeavours to eradicate poverty and hunger a priority target population should be the households of the sub-marginal-size farms and of the land-less agricultural labourers.

Farm households consume as well as produce food items. The households' consumption patterns and purchasing decisions are based on household size and needs, on the extent to which the concerned items are produced on the household farm, and on the nature, quantity, and price for items that need to be purchased. The All-India surveys on consumer expenditure specify - for various foods and food groups - the extent to which households meet their food requirements from their own production.

The 1993-94 Survey (Table 22) indicates that in aggregate over all farm sizes, home-produced foods supplied about one-half of the households' consumption of calories, proteins, and fats, and more than one-half of the cereals and milk products. However, for almost all listed items, the sub-marginal households produced proportionately less than the all-farms averages.

Table 21: Home-produced calories: Relationship to poverty and hunger: 1983 and 1993: Various farm-size categories: Rural India

Farm-size category	Proportion (%) of consumed calories produced on own holding	Per cent of human population			
		Poor		Under-nourished	
		1983	1993	1983	1993
Sub-marginal	<25	52	38	49	36
	25-50	44	35	34	33
	50-75	41	29	28	29
	>75	43	39	23	21
Marginal	<25	48	28	35	32
	25-50	43	24	28	27
	50-75	36	19	28	23
	>75	41	29	23	18
Small	<25	44	21	28	25
	25-50	36	13	26	16
	50-75	33	13	25	18
	>75	38	21	21	14
Medium	<25	40	11	23	15
	25-50	27	10	22	17
	50-75	24	11	20	13
	>75	34	17	17	8
Large	<25	27	15	14	15
	25-50	20	8	17	10
	50-75	17	9	17	12
	>75	27	17	15	10

Source: Computed from household data in the National Sample Survey (38th and 50th Rounds).

Table 22 permits insight also into the extent of diversification of the farming systems: those farms that produce themselves proportionately more of their food and nutritional needs may be presumed to be agriculturally more diverse. Table 22 thus suggests that the larger farms are more diverse than the smaller ones. However, this suggestion would be contrary to the tentative conclusions drawn from tables 7, 8, and 9.

Farms of each size produce three-fourths or more of the milk and milk products that they consume. This perhaps constitutes a strength and asset that can be built upon. Recalling that households having sub-marginal- and marginal-size farms are net buyers of crop-derived foods, then interventions to strengthen the *livestock component* on such holdings could help increase both home-grown food supply and also income.

Table 22: Proportion (%) of the household's food items, calories, protein, and fats that are home-produced: 1993-94: Various farm-size categories: Rural India

Item	Sub-marginal	Marginal	Small	Medium	Large	All farms
Cereals	45	69	73	74	69	59
Pulses	18	36	45	50	55	33
Milk + products	75	83	87	90	91	83
Fats and oils	7	16	21	20	15	14
Meat, fish, eggs	15	21	22	19	15	18
Vegetables	24	31	32	29	25	28
Fruits	37	32	26	19	17	31
Sugar, jaggery	2	5	6	6	4	4
Others	18	30	28	29	28	25
Total calories	41	60	64	65	61	53
Total protein	42	62	67	69	67	55
Total fats	36	50	57	58	57	47

Source: Computed from household data in the National Sample Survey (50th Round - 1993-94): All-India survey on consumer expenditure, employment, and unemployment.

Among India's population (at 1998) of nearly one billion, 250 million are poor. Of those poor, about two-thirds (170 million) are rural dwellers (Singh, 2001: as compared to the Appendix-1 value of 150 million, this 170 million includes the rural land-less). Table 23 lists the proportion of *poor persons* in the various farm-size categories at various years during 1983-98. That proportion is highest for the sub-marginal category, and decreases as farm size increases. For the sub-marginal category, the proportion of poor at 1983 was 54 percent; this proportion decreased to 38 per cent (nonetheless representing 89 million persons) by 1993 as new technologies helped raise agricultural productivity. For all farm sizes, poverty incidence decreased during 1983-1998 at roughly 5 % / annum; however, this rate of decrease has been less in later years than in earlier ones.

Table 23: Poverty incidence in rural households: Various years 1983-1998; Various farm-size categories

Year	Proportion (%) of poor persons					
	Sub-marginal	Marginal	Small	Medium	Large	All farms
1983	54	46	41	35	25	42
1988	39	30	23	17	11	31
1993	38	27	19	14	13	29
1994	31	27	23	17	13	25
1995	25	21	18	17	15	21
1996	24	21	16	14	10	20
1998	28	23	18	15	10	22
Rate of decrease (% / ann)	5.1	4.9	5.5	5.1	4.6	4.8

Source: Computed from household data in National Sample Surveys (Various Rounds - 1983-1998)

Table 24 complements Table 23 in listing the corresponding incidence of *under-nourishment* (but for Years 1983, 1988, and 1993 only). The Table-24 data are based on a minimum (threshold) food-energy requirement for rural India of 1 800 kcal / person.day (representing 75 % of the Planning Commission's poverty-line threshold of 2 400 kcal / person.day; for an average individual, an intake below this threshold is not sufficient to maintain health and body mass, nor to support light physical activity).

For all farm-size categories and for each year, the proportions (Table 24) of under-nourished are lower than the proportions of poor: the farm households are producers as well as consumers of some foods, and can thereby supply from their own produce much of their dietary-energy requirement. Under-nourishment was and is most prevalent among sub-marginal-farm households: 45 per cent in 1983, subsequently decreased by 1993 to 32 per cent (nonetheless representing 75 million persons). During 1983-1993 under-nourishment decreased at about 3 % / annum.

Table 24: Incidence of hunger in rural households: At 1983, 1988, and 1993; Various farm-size categories

Year	Proportion (%) of under-nourished persons					
	Sub-marginal	Marginal	Small	Medium	Large	All farms
1983	45	31	25	21	15	29
1988	29	21	16	14	10	23
1993	32	24	17	12	12	25
Rate of decrease (% / ann)	3.3	2.5	3.8	5.4	2.2	1.5

Source: Computed from household data in National Sample Surveys (Various Rounds - 1983-1993)
Note: Using a threshold energy intake of 1 800 kcal / person.day. (Text refers.)

Table 25 lists for the various farm sizes and for Years 1983, 1988, and 1993 an estimation of *intensity of hunger* (or food deficit) for those arbitrarily defined as under-nourished. (Table 19 used the same survey data in relation to the livestock influence on

Table 25: Intensity of hunger in under-nourished rural households: At 1983, 1988, and 1993; Various farm-size categories

Year	Food deficit (kcal / person.day) among those designated as undernourished					
	Sub-marginal	Marginal	Small	Medium	Large	All farms
1983	429 (81)	354 (81)	348 (79)	338 (76)	338 (71)	374 (79)
1988	332 (76)	315 (75)	356 (73)	361 (70)	372 (67)	332 (75)
1993	307 (76)	280 (75)	266 (71)	253 (68)	256 (67)	293 (75)
Rate of decrease (% / ann)	3.3	2.3	2.6	2.8	2.7	2.4

Source: Computed from household data in National Sample Surveys (Various Rounds - 1983-1993)
Note: Value in parentheses is percentage of dietary energy supplied by cereals.

hunger.) Intensity of hunger relates to mortality rate, life expectancy, and productivity at work (FAO, 2000). Thus, while the average food deficit (aggregate for all farm sizes) of the undernourished did decrease from 374 to 293 kcal / person.day during 1983-1993, those food-deficit values are so high as to cause concern.

Relatedly, Table 26 lists, for various years during 1983-1998, the proportions (%) - among the five farm-size categories - of all rural farming households that are assessed as poor, or as under-nourished. (Table 26 thus complements Tables 23 and 24, which derive from the same surveys.) These Table-26 proportions may be interpreted in conjunction with the trends (Table 1) in the total numbers of farm households (poor and non-poor) at 1971 and 1991. Thus, interpolation within Table 1 suggests that at 1983 the *sub-marginal* category may have included about 37 per cent of all farm households, and at 1993 about 40 per cent. Table 26 indicates that at each of those years the *sub-marginal* category included a substantially higher proportion - about 49 per cent - of all *under-nourished* farm households; it indicates also that at 1983 the *sub-marginal* category included 42 per cent of all *poor* households, with that proportion having risen to about 50 per cent at 1993 and 1998. Thus - and perhaps not unexpectedly - the sub-marginal households are over-represented among the numbers of under-nourished and poor farm households. Correspondingly, the large- and the medium-size-farm households are under-represented.

Table 26: Proportions of all *under-nourished* and of all *poor* households within various farm size groups: 1983-1998: Rural India

Farm-size category	**Proportion (%) of all *under-nourished* farm households in each farm-size category**			**Proportion (%) of all *poor* farm households that are in each farm-size category**			
	1983	**1988**	**1993**	**1983**	**1988**	**1993**	**1998***
Sub-marginal	48.6	46.9	49.6	41.6	46.8	50.9	49.7
Marginal	17.4	19.5	20.6	18.4	20.7	20.0	20.8
Small	15.9	16.6	15.9	18.6	17.7	15.4	16.5
Medium	11.2	11.0	8.3	13.3	9.9	8.4	9.2
Large	6.9	6.0	5.6	8.2	4.9	5.3	3.9
All farms	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Computed from household data in National Sample Surveys (38th, 43rd, 50th, and 54th Rounds): Consumer household expenditure based on sample estimates.

* Based on small sample.

The intensely hungry persons (Table 25) are clearly highly vulnerable. Many of them (Table 26) are likely to belong to sub-marginal-farm households. They must be accorded priority within food-security and poverty-alleviation programmes. Similarly, India's responses to the World Food Summit Target (to decrease by one-half by 2015 the world total of hungry persons), and to the Prime Minister's Challenge (to double food production and make India hunger-free by 2010), must include the raising of income and employment among sub-marginal-farm households. These households are

net food buyers, and need cash wherewith to buy that portion of their food requirement that they cannot themselves produce. Their only cash-earning sources are the sale of their labour and such marketable products as they can generate through intensification and diversification of their on-farm activities.

Table 1 indicates that the average size of a sub-marginal holding (at 1971 and 1991) was 0.23 ha. A land-holding of 0.23 ha has an area equal to about one-half that of a field-hockey pitch. Can an area of 0.23 ha (or even of 0.5 ha) generate income in excess of the poverty-line value and also supply the minimum dietary energy requirement for the household? A definite answer is not yet available. However, the analyses of Tables 21 and 19 suggest that the ownership of some land (however little) or of a single animal confers to the sub-marginal-farm households an advantage (compared to land-less-labour households) in resisting hunger and poverty.

However, many other factors - of technology and of policy - determine the extent and intensity of hunger and poverty in rural India. Such factors include irrigation and other inputs supply, appropriate technologies for crops, livestock, and on-farm fisheries, integrated rural development programmes (with literacy-enhancement component), off-farm employment opportunities, and public distribution systems. States which have addressed these factors through integrated programmes - West Bengal, Kerala, Punjab, and Tamil Nadu - have successfully reduced poverty and food insecurity (Singh, 2001).

VIII. GLOBALIZED TRADE AND SMALL-HOLDER AGRICULTURE

Trade, especially international trade, reputedly contributes to poverty reduction and food security. Does this statement hold true for small-holder farmers in developing countries? For India, three questions arise. Firstly, do the small farmers generate marketable surpluses? - if not, can they be assisted to generate surpluses in appropriate regions and commodities? Secondly, how should small-scale agriculture compete with imported products, and what trade protection is needed? Thirdly, can small-holders benefit from export opportunities, and are there market-access constraints that need to be overcome? We here attempt to answer those questions.

Globalization of agricultural trade will highlight: access to markets; new opportunities for employment and income generation; productivity gains and increased investment in sustainable agriculture and rural development. If managed well, liberalization of agricultural markets will benefit developing countries in the long term. It will force the adoption of new technologies, shift production functions upwards, and attract new capital into deprived sectors. However, such benefits will accrue only if due attention is directed to the short- and medium-term interests of hundreds of millions of small-scale, subsistence-oriented farmers, fisher-folk, and forest dwellers. The magic of globalization has not yet been felt in India.

To the first question: Table 27 analyses trends (1970-1990) for marketable surplus among major commodities. However, as was cautioned in relation to Tables 3, 4, 6, these Table-27 estimates similarly presume yields to have been *equal* among all farm-size categories. If smaller farms had *higher* productivity than larger ones, then estimates for the marketable surplus from small-holdings should be increased, and estimates for their extent of net buying correspondingly decreased. Nonetheless, Table 27 does permit the conclusion that in almost all years *sub-marginal-* and *marginal-size* households were net buyers of all of the listed commodities, including the food-grains. Farms larger than 1.0 ha (the small, medium, and large categories) produced the aggregate marketable surplus.

At 1970, the *small-size* holdings (1.0 - 2.0 ha) also were net buyers or produced meagre surpluses. However, and notably, at 1990-91 these small-size holdings generated a marketable surplus of 7.2 Mt/ann (million ton per annum) of rice, 1.3 Mt/ann of wheat, 2.1 Mt/ann of coarse cereals, and 1.7 Mt/ann of oilseeds. Correspondingly, during 1970-1990 the proportion of these *small farms'* aggregate production of *rice* that was contributed to the market increased from zero to 42 percent. For *wheat,* there was transformation from net buyer to a contribution of 12 per cent of production to the market, for *oilseeds* from net buyer to a contribution of 71 per cent, and for the *coarse cereals* the marketed proportion increased from 5 to 34 per cent. Similarly, for the *marginal*-size- and the *sub-marginal*-size-farm households, the magnitude of the food-purchase requirement lessened appreciably during 1970-1990.

Within a free-market economy, the contributions and the importance of the small, marginal, and sub-marginal farms will increase. Consequently, the needs and aspirations of these farm families must feature prominently in policies of market reform that correct acknowledged distortions and that seek to improve food and nutritional security - both in these small-holder households and nationally. Relatedly, small-

holders may become more vulnerable and more disadvantaged as the global agricultural economy enlarges immensely through the expansion of international-trade liberalization.

Table 27: Marketable surplus (all India) in major commodities: Years 1970, 1980, 1990; Various farm-size categories

Crop	Farm-size category	Marketable surplus (million ton per ann)			Marketable surplus / category's production (%)		
		1970	1980	1990	1970	1980	1990
Rice	Sub-marginal	-8.45	-13.97	-13.14	-	-	-
	Marginal	-2.19	-2.82	-0.07	-	-	-
	Small	0.01	1.85	7.20	0	16	42
	Medium	4.12	7.62	12.28	42	56	66
	Large	11.19	13.00	16.01	73	75	80
Wheat	Sub-marginal	-3.79	-5.65	-4.92	-	-	-
	Marginal	-1.34	-2.11	0.11	-	-	2
	Small	-0.74	-2.33	1.26	-	-	12
	Medium	0.60	0.23	4.52	12	3	35
	Large	7.17	7.89	15.38	56	49	72
Coarse cereal	Sub-marginal	-2.14	-2.69	-2.37	-	-	-
	Marginal	-0.91	-1.21	-0.33	-	-	-
	Small	0.16	-0.21	2.08	5	-	34
	Medium	1.99	2.11	5.24	35	32	60
	Large	13.32	12.79	12.92	69	74	80
Pulses	Sub-marginal	-0.58	-1.32	-1.43	-	-	-
	Marginal	0.07	-0.50	-0.51	-	-	-
	Small	0.28	-0.37	-0.19	23	-	-
	Medium	1.04	0.46	0.74	51	24	37
	Large	5.56	3.86	3.71	80	72	79
Oilseeds	Sub-marginal	-1.25	-0.34	-0.18	-	-	-
	Marginal	-0.64	0.02	0.52	-	4	48
	Small	-0.60	0.45	1.745	-	46	71
	Medium	-0.03	1.19	3.093	-	70	84
	Large	3.11	3.73	6.958	67	88	94

Source: Computed from various data in Agricultural Census, Agricultural Statistics at a Glance, and Consumer Household Survey in National Sample Surveys (Various Rounds - 1970-1990)

Notes: (-) indicates no marketable surplus generated.

Negative marketable surplus means farmers are net buyers: this category of farm size does not contribute to the supply to consumers. Marketable surplus is production *less* consumption. Consumption is number of households (from census data) x per household annual consumption (from NSS consumer expenditure budget survey). Production is crop area within farm-size category (from Agricultural Census) x average yield (Ministry of Agriculture estimates).

There shall be crucial need for safety nets during the structural adjustment process. Particularly, and noting the smallness of the market surplus generated by small-holder farmers, the domestic markets must be protected - using the permitted WTO mechanisms - against international dominance of nationally-vital agricultural food items. Without such action - especially in relation to pulses, oilseeds, and edible oils - there is likely to be adverse consequence for within-farm diversification.

To the second question (can Indian agriculture compete globally?): Building on its 1991 economic reform programmes, India has implemented several agricultural-trade liberalization initiatives (Chand and Jha, 2001). Thus, restrictions on imports and exports have been removed, and tariff rates have been progressively lessened. In consequence, agricultural exports and imports each increased sharply, and the share of agricultural trade in agricultural GDP increased from 6 to 9 per cent. Prices received for Indian exports, and prices paid for imports, were each 15 to 20 per cent below international-market prices for comparable products. Thus there was no net social gain from rice and wheat exports, nor for soybean imports. In the case of pulses, there was a positive net social gain.

When international prices fluctuate widely, the impacts are felt by small producers and poor consumers - who in India constitute the majority of the populace. Protection of these producers and consumers should be achieved through timely and WTO-permitted interventions guided by monitoring and analysis of international prices. Chand and Jha (2001) concluded that attempts to increase exports of grains and raw materials are not likely to be a beneficial proposition - particularly as international prices for these commodities are forecast to remain low. However, they identified potential for export of processed agricultural products. Similarly, Vyas (2000) found no justification to promote export or import of food-grains, and advocated the continuance of the current policy of self-sufficiency in food-grains unless and until opportunities arise for cost-effective and price-competitive surpluses.

However, since the early-1990s' acceleration of trade liberalization, there have in India been various unforeseen developments. The growth rates in agricultural GDP and in crop yields and in non-agricultural employment have all been less than forecast. Thus, and as we expressed in relation to our first question, trade liberalization must be pursued with due concern and action to achieve for rural populations a just, inclusive, equitable, and sustainable way of life, and there must be effective measures to ease the adjustment process for small-holder households.

Notwithstanding (Tables 23 and 24) India's progress in lessening the incidence of poverty and hunger among the marginal-size- and sub-marginal-size-farm households, those 80 million households (400 million persons) are still net buyers (Table 27) of food-grains. Consequently, the country's trade policy should continue to be formulated within a national strategy for sustainable food security, employment security, and poverty reduction. Encouragingly, the small, marginal, and sub-marginal-size holdings have progressively adopted new technologies and have often increased productivity more quickly than the larger holdings. The small-holder farmers should be further empowered to increase productivity of both land and labour, and to augment their income through off-farm employment and enterprises.

The net buyers of food - comprising many marginal-size- and sub-marginal-size-farm households, many land-less-labourer households, and the non-agricultural population - would welcome low-priced food. With international food-grain prices now lower than domestic prices, there might thus be logic in the Government importing and distributing food to the needy. However, matters are not so simple. Cheaper imports will rapidly depress prices in domestic markets - and hence farm-gate prices, and will impact adversely the livelihood of almost all farmers; they would correspondingly distort cropping / farming patterns and consequently the availability of on-farm employment and its associated wages. Free-trade importation of agricultural products would thus in India equate to large-scale importation of unemployment, poverty, and hunger. It is highly pertinent that in India more than 600 million people depend on agricultural employment. Consequences shall be similarly adverse if international food-grain prices soar, while domestic supply falls.

Often, international prices are lower than Indian domestic prices - as is the case with edible oils - primarily because of large subsidies to exporting-country producers. As a counter, domestic markets impose tariffs. Thus, as was previewed in an earlier paragraph, the levels for such tariffs must be professionally determined and dynamically adjusted. India should therefore continue to pursue vigorously the incorporation of a "food-security box" within the WTO procedures. Indeed, the concept of "a level playing field" is far from being achieved and practised. The OECD-country subsidies to agriculture amount to US$ 1 billion a day. It is difficult to maintain a level playing field when such huge humps are created each day!

In India, government intervention in agricultural markets are pervasive - notwith-standing that 80 per cent of agricultural-commodity trade is through the private sector. During the Green Revolution, government pricing policy provided incentives to producers to encourage adoption of new technologies. Currently, India's agricultural-prices policies include several pro-poor and farmer-friendly features: minimum support prices, selective market intervention, encouragement to producers and/or consumers co-operatives, cereals buffer stocks, and distribution of subsidized food-grains through the Public Distribution System (Acharya, 2001). These features have resulted in improved market integration (Wilson, 2001); they can help also to lessen food insecurity and poverty.

India's populace appreciates this government policy of subsidizing farm inputs and thereby restraining food prices so that affordable food is everywhere available. All sectors of society have thereby benefited: small-holder families, landless labourers, other resource-poor families, surplus-generating farmers, the net buyers of food, urban consumers, and manufacturing industry.

Nonetheless, policies and strategies will need to be kept dynamic to accommodate the ever-changing situations and issues of domestic demand and supply, the role of agriculture and its small-holder farms in the national economy, the profiles of food insecurity and of poverty, societal inequities and regional disparities in development, and economic liberalization and globalization. Among those issues there are contradictions and conflicts: no trade policy and strategy, however comprehensive, can hope to reconcile and integrate them all. There must thus be compromises in trade policies. India' agricultural-trade policy must address with priority the welfare of small-holder farmers and the issues of food insecurity and poverty. Protection of domestic

agriculture remains the foremost priority, but consequential increases in prices of food and of non-food agricultural products, and in wage rates, must be restrained. The several trades-off must continue to be carefully researched and to be transparently debated - with due concern for the interests of the rural poor.

As a consequence of its vast area and population, India has much agro-ecological diversity and many socio-economic inter-regional disparities. It is thus requisite that the country should reform its domestic markets before it links them to the global market. Crucially, the sequencing of the reforms must be apposite. Thus, liberalization of domestic markets - including the removal of inter-state movement restrictions - must precede trade liberalization. Effective functioning of domestic markets and a strengthening of farm / non-farm linkages are essential in addressing the needs of small-holder farmers. There is evidence that those countries that failed to sequence their liberalization activities in an appropriate and effective manner subsequently struggle to benefit from the new opportunities.

Notwithstanding the positive impacts of India's various inter-related policy instruments in achieving food self-sufficiency by the late 1980s, inefficient implementation has lessened their effectiveness, and there have been several distortions (Vyas, 2000). Minimum support prices, which are now the same as procurement prices, have escalated; the obligation to purchase, at the procurement price, all offered grain has resulted in unmanageably huge stocks (over 50 million tonnes) - far in excess of what is required by the Public Distribution System (PDS). The government is finding it difficult to dispose of the excess, and may be compelled to export part of it at much below the currenty low international price. The high procurement price, coupled with high and escalating costs of procuring, storing, and distributing the grain, has raised the PDS issuing price, thereby confronting the PDS objective of supporting the food-insecure and vulnerable people.

The main beneficiaries of this situation have been the larger, surplus-producing farmers. Moreover, the costs of the subsidy have escalated, thereby preventing Indian agriculture from deploying its scarce resources in more-productive investments such as rural-infrastructure development, research and extension, and reaching the yet-un-reached. The policy of minimum guaranteed prices and of subsidy for food and agricultural inputs should be restricted to small-holdings, and to the needy and poor. Subsidies enjoyed by the non-poor - in both the farm and the non-farm sectors - should be progressively eliminated, and the resources thus released effectively used for generating and diffusing modern technologies, for value-addition in small-holder agriculture, and for rural infra-structural and social development.

The third question asked whether India's small-holders might benefit from exports within globalized markets, and whether their access to such markets would be constrained. India here faces a dilemma: it must protect its own agricultural production against import-induced instability, but it must also capture export opportunities. Our preceding analyses have demonstrated that small-holders have responded to market forces and opportunities by adapting and adopting new and diversified cropping and farming systems. For those of their products / commodities that have a favourable of export / domestic price ratio, and for which there is stable international-market demand, and for which surpluses can be maintained - after meeting the needs of poorer people - export should be facilitated and promoted. Candidates would include the *commercial*

and *cash* crops: cotton, tea, jute, some fruits (grape, mango, litchi) and vegetables (okra, onion) and flowers. There are firm prospects also for existing and for new *speciality products:* basmati rice, glutinous rice, and durum wheat. [A supportive benefit of an intensification of *durum* wheat production - in Madhya Pradesh - would be a major lessening of rust incidence and damage in India's *bread*-wheat belt (Pandey *et al,* 2000) by increasing the genetic diversity for rust resistance and hence suppressing inoculam build-up and spread.]

Herbal medicines are increasingly in demand in industrialized countries. India has a rich heritage of developing and using such medicines. Moreover, it has high bio-diversity among such herbs, and has also a complementary agro-ecological diversity within which to produce / harvest medicinal plants and botanicals. India's prospects for using these resources are perhaps the world's brightest - notwithstanding that China is currently making better use of its similar, but lesser, resources.

India needs a concerted effort to realize these prospects: perhaps through specialized herbal-medicine co-operatives linked to small-scale rural production, processing, and value-addition units. There would be need also for effective quality-control and marketing, and for infra-structural, institutional, and export-procedures support. Such innovations would boost national export and income, and strengthen health-care services for the Indian people. Such ventures involve high-value low-volume products that are suited to small-scale production and processing; they are thus highly appropriate for hill farms, which necessarily are small; moreover, most medicinal and essential-oil and aromatic plants are already grown in such areas. Herbal-medicine production systems could thus be incorporated - with beneficial synergism - into agro-forestry systems and wasteland-development programmes. Such venture and systems would promote agricultural diversification, and increase on-farm and off-farm employment and income - notably among the small, marginal, and sub-marginal-size holdings.

For small-holders there is also a powerful opportunity to compete in the industrial-world's strengthening market for certified *organically-grown* agricultural products. Our earlier analyses showed that the mixed crop / livestock systems - which generate the required quantities of "organic" manures and which facilitate desirable crop diversification and nutrients recycling - are in India practised predominantly on the smaller holdings. A nationally co-ordinated system for production, certification, distribution, and export of such products - with international promotion, and preferably co-operatives-based - merits strong public- and private-sector support.

IX. EMPOWERING THE SMALL-HOLDERS

Off-Farm Employment:

Small-holders are under continuous pressure to increase production from their limited land resource. Thus, the sub-marginal- and marginal-size farms cannot remain "subsistence-oriented". Policies and strategies - existing and new - must help diversify on-farm and *off-farm activities* and thereby enhance sustainability and productivity. The income from off-farm and non-farm employment assists the small-farm households to become or remain hunger-free. Through effectively-managed "monetization", small-farm households could benefit from globalization and avoid poverty. In China, agricultural renewal was complemented by the creation of gainful non-agricultural employment: almost 100 million persons were withdrawn from the agricultural sector and employed in non-agricultural enterprises in rural townships. This transfer was facilitated by government-initiated programmes of human-resource and skills development; the people thereby trained are now a major force in the production of several non-agricultural goods and items.

Amartya Sen (1999) demonstrated that during years when non-agricultural rural employment increases, rural poverty declines, and that the converse also holds. Thus, on-farm, off-farm, and on-off-farm rural employment is essential to combat rural poverty and to secure adequate livelihood within the households of small-holders and land-less agricultural labourers. Such employment would lessen the urban migration of the rural poor, and thereby help prevent the urbanization of poverty.

There had been expectation that trade liberalisation would promote non-agricultural rural employment and hence enable many under-employed small-holder farmers to engage part-time in off-farm income-generating activities. Through such additional income, the small-holder households would have an increased ability to purchase food, and an enhanced social status; some part of the additional income might expect to be invested in the household farm to intensify, diversify, and enhance productivity. Regrettably, and generally, this has not come to pass; in the interest of the nation - in both its rural and its urban sectors - the reasons and the remedies must be determined.

In India's peri-urban areas and in the off-seasons, small-holder farmers engage in off-farm paid work. Such work may be in the tourism and eco-tourism industry, in off-shore assembly, or in various agriculture-related or non-agriculture-related enterprises. In comparison to rural (often remote) areas, the peri-urban areas are usually better endowed with road, transport, market, and other infra-structures; they thereby have easier access to off-season employment opportunities, and their poor people are less poor than the rural poor. For the rural poor, strengthened rural infra-structures - particularly connections to major roads and highways - would facilitate the development of small enterprises, agro-based activities, and markets, and increase off-farm and non-farm employment opportunities. Small and medium-size rural enterprises are likely to be more successful when buttressed by strategic alliances - among themselves and/or with larger, possibly urban-based, enterprises (as in China).

FAO's Investment Centre helps FAO-Member countries to mobilize investments that facilitate the growth of rural enterprises and employment. Assistance includes:

- Decentralizing public-revenue use, and providing resources for local priorities;
- Developing rural infrastructure to meet the needs of rural enterprises;
- Facilitating flexible financing for new and growing enterprises;
- Strengthening local rural-enterprise-development organizations;
- Supporting rural-area export and marketing associations;
- Developing guidelines for small enterprise management and administration; and
- Providing planning tools to increase the quality for small and medium-scale investment proposals.

The small-holder contributions to India's food security have during recent decades increased considerably - notwithstanding that the small-holder households are themselves highly vulnerable and insecure. For these households - and particularly for those dependent on marginal- and sub-marginal-size farms - off-farm and non-farm employment can be vital in lessening hunger and poverty. However, and as was previously indicated, liberalization of agricultural trade has not increased rural-area non-agricultural employment. Remedies might include increased budgetary allocations and expanded banking-system rural credit for *non-farm* employment-creating rural enterprises.

Correspondingly, the rural-household members - males and females - shall require skills-development programmes to strengthen their decision-making capabilities and to increase their labour productivity. Such human-resource development - in agricultural and in non-agricultural aspects - has high priority, and shall be essential if economic and social goals are to be attained. The rural farm- and non-farm economies are intimately inter-connected; there shall thus be crucial need to maintain balance between the agricultural and the non-agricultural employment sectors.

Agrarian Reform

The major endowment of a poor small-holder household is its *labour*. Thus, if there is to be national economic growth with equity, those households' entitlements must be increased by the availability of more and new employment opportunities (Sen, 1999). If national economic growth is not managed suitably, there can be increased inequality. It is therefore encouraging that previous and ongoing *agrarian reforms* have lessened the inequality in access to land, water, credit, knowledge, and markets, and in income distribution; simultaneously, they have increased agricultural productivity. Such reforms must be adopted to the widest possible extent. Secure access to natural resources encourages sustainable production; it also helps insulate small-holders against displacement from their holdings as a result of encroachment by agricultural or non-agricultural entities. It is relevant for India that the strong economic growth and poverty eradication in the Republic of Korea and in Taiwan were each triggered by effective redistributive agrarian-reform programmes. In India, as elsewhere, agrarian reform shall be most effective when complemented by interventions to strengthen infrastructures and access to health care and other social services, and to agricultural inputs.

Notwithstanding that India's land reforms have been generally effective, there have been demands that land ceilings should be raised in order to attract increased capital investment in agriculture. However, Tables 10, 14, 15 preceding indicate that the largest farms have lower cropping intensity, apply less manure per hectare, and have proportionately less irrigation than the farms smaller than 1.0 ha. The larger farms are

thus likely to have lower productivity than those smaller ones. It can be logically argued that large-farm productivity would be raised if increased farm size encouraged additional capital investment. Conversely, it may also be reasoned - perhaps more cogently - that the same capital directed to the smallest farms would have an equal or greater effect on productivity; it would certainly there have a more-desirable social effect.

There are, however, opportunities in Indian agriculture where investment to gain benefit from economies of scale is both feasible and worthwhile. Notable such opportunities arise in processing, value-addition, and distribution of produce. There are successful experiences of large-scale (co-operative) milk processing in Gujarat and of sugarcane processing in Maharashtra. Such examples should be replicated in other states, and the methodology adapted for should be adopted for other commodities and products.

Socially, a policy of raised land ceilings may result in an undesirable increase in rural-urban migration. Notwithstanding that ownership of land (however little) lessens hunger and poverty (Agarwal, 1994) and constitutes a major livelihood-security asset (Swaminathan, 2000), many farmers of marginal- or of sub-marginal-size holdings may consider their holding to be too small to support a household livelihood, and in consequence abandon their food-security base, and seek alternative livelihood in the conurbations. Many thereby transform themselves from rural poor to urban destitute. That tendency must not be encouraged by land-ownership policy.

Nonetheless, and recognizing a justified concern among those would-be migrants, a possible remedy would be to liberalize - with appropriate safeguards - the land-lease market. There could thereby be a mechanism of exit - but with right of return - for those who wish to explore alternative livelihoods. The mechanism would also provide opportunity to other small-holder families to augment their holdings and render them more viable. Liberalization of the lease market should feature prominently among options for economic reform of Indian agriculture.

Education

Table 28 quantifies the associations of educational attainment (a proxy for literacy and numeracy) with poverty and under-nourishment on farms of various sizes at 1983 and 1993; education is here specified for the head of household only. The general importance to agriculture of literacy and numeracy is in the correlation of those attainments with the utilization of new or/and existing technologies (Fan *et al,* 1999; Kumar and Mittal, 2000).

Table 28 indicates that education - even if primary education only - was at both samplings strongly associated with lesser incidence of *poverty.* An association was apparent also for *under-nourishment* at the 1993 survey, but not at 1983. However, it is necessary to emphasize that in interpretations from Table 28 it is not possible to assign *effect and cause:* education may have assisted in income generation and in lessening of poverty, but equally probably, increased income and wealth may have financed the purchase of education. But we may indeed conclude - specifically from the entries for the non-educated category - that between 1983 and 1993 there was a substantial decrease in poverty incidence, and a lesser decrease in under-nourishment, that were *not* associated with educational attainment. The associations apparent in Table 28, notably

for poverty, do however indicate that associations - whatever be cause and what be effect - were pronounced not only when education increased from "none" to "below primary", but also when it increased from "below primary" to "above primary".

Table 28: Education: Relations to human poverty and hunger: 1983 and 1993: Various farm-size categories; (Rural India only)

Farm-size category	Education attainment of head of household	Percentage of population			
		Poor		Under-nourished	
		1983	1993	1983	1993
Sub-marginal	None	61	48	44	35
	Below Primary	52	35	51	33
	Above Primary	40	26	43	27
	Graduate / Technical	17	11	18	17
Marginal	None	50	37	31	28
	Below Primary	46	22	34	22
	Above Primary	36	18	30	20
	Graduate / Technical	21	8	23	11
Small	None	46	27	26	23
	Below Primary	38	16	24	16
	Above Primary	31	12	24	14
	Graduate / Technical	18	6	20	5
Medium	None	41	21	23	15
	Below Primary	33	14	23	15
	Above Primary	24	9	18	9
	Graduate / Technical	16	7	15	4
Large	None	31	20	17	14
	Below Primary	23	16	15	15
	Above Primary	15	6	12	9
	Graduate / Technical	11	10	13	8
All farms	None	48	40	30	30
	Below Primary	40	26	31	25
	Above Primary	30	19	26	20
	Graduate / Technical	17	8	18	11

Source: Kumar and Mittal, 2000

Notwithstanding these difficulties of interpretation, it is without doubt essential that maximal effort and resources be directed to rural education and to the dissemination of agricultural information. It is correspondingly significant that almost one-half of the heads of India's farm households lack formal education; it is pertinent also that more than four-fifths of India's child labour work in the agricultural sector, and that most of

those children belong to small-holder families. Educational attainment is similarly important in helping narrow the yield gaps and productivity gaps that persist throughout much of India's agriculture, and correspondingly in helping raise total factor productivity. There are indeed proven methodologies for closing some of those gaps and for raising factor productivity; adoption of those methodologies shall be more rapid when the agricultural population is better educated. Rural-education policy must thus seek to ensure at-least-primary education for all rural dwellers at the earliest possible date. The policy, and its implementation, must attract farm-family children to the schools - perhaps featuring free education and a free mid-day meal to Eighth Grade. In addition to serving agriculture's needs, such a policy (Chaudhri, 2000) would help meet children's rights, rights to food, rights to development, and human rights in general.

An Expanded Role for Information Technology

People need information to make decisions about their livelihoods. In poor rural areas, where agricultural productivity is low and unreliable and there is food insecurity, better information and knowledge-exchange can be important in lessening poverty. In an enabling environment, information can empower poor people to determine their own livelihoods. However, the required information must be exchanged in a way that enables poor people to participate in the design and selection of those information tools, media, and content that are appropriate to their specific needs.

Understandably, the current generation of small-holder farmers has little inclination and capability to access and to absorb electronically-distributed information on agricultural technology. However, their more-educated children may be expected to be both capable and enthusiastic so to do. Thus, up-to-date agriculture-related information and data, and their dissemination through cyberspace informatics tools, can and must equip the future small-holder farmers with the knowledge they shall need to help them organise themselves and their farms for collective action within their "agricultural-production watersheds".

In India, the National Information Centre (NIC) of the Ministry of Information Technology - through initiatives such as the DISNIC-Agris Project, and AGRISNET (a NIC-net based Agricultural Informatics and Communications Network) - seeks to reach all agricultural districts and blocks through its massive "Gateway Networks". Through these networks, farmers will have opportunity to learn of and benefit from new and improved agricultural practices, to have weather-forecast-based guidance for timely agricultural operations, to be alerted by satellite surveys of pests and diseases, and to access crop-output forecasting and marketing strategies for domestic and for export trade.
Globally, the FAO-facilitated World Agricultural Information Centre (WAICENT) is a strategic facility for management and dissemination of information for agriculture - particularly for developing-country agriculture. WAICENT has four priorities: human-resources development, community development, information content, and systems development. Specific collaborative programs are being established in FAO Member Countries to enable national agencies to incorporate *international* information within their national information systems.

The WAICENT-Outreach Program is the platform wherewith FAO helps create systems for knowledge exchange in Member Countries and throughout the international

community. This Outreach Program strives to enhance the ability of individuals and communities in Member Countries to improve the efficiency, quality, and relevance of information and knowledge exchange. Particularly it seeks to facilitate information exchange among the various stakeholders concerned with agricultural development and food security, and has focus on the world's most vulnerable and deprived people. Thus, an early and important example of a system wherewith national agencies incorporate *international* information within their national system is the Food Insecurity and Vulnerability Information and Mapping System (FIVIMS). This system is building national capacity to generate and to use accurate and timely information on the incidence, nature and causes of food insecurity and vulnerability.

Rural-community knowledge systems can be created using a series of modules. These modules comprise specialized information systems and communications networks based on ICTs (Information Communication Technologies). FAO has developed the Virtual Extension, Research, and Communication Network (VERCON) and the Farmer Information Network for Agricultural and Rural Development (FarmNet). These networks have been developed to help improve co-ordination and collaboration between national extension services and agricultural research institutions. Linkage of a FarmNet to a VERCON will provide to farmers an improved access to technical expertise; correspondingly, it will help researchers and extensionists to understand the local, site-specific problems faced by small-holders, and to appreciate the practices that farmers apply in their farming systems. In India, FAO WAICENT and the UK's Department of International Development are helping develop and operate a "strategic programme for information in support of sustainable livelihoods".

Development and Diffusion of Appropriate Technologies

Improved agricultural technologies are "size-neutral"; however, some of them are not "resource-neutral". Hence in generating improved agricultural technologies, small-holder-oriented research and extension should emphasize "cost reduction without yield reduction". This might be pursued through integration of non-monetary inputs, low-cost technologies such as integrated pest management, integrated plant nutrition systems, water harvesting and recycling, and monitoring of efficiency of use of natural and purchased resources. There shall thus be need - as stressed in preceding sections - for enhanced and sustained investment in research, technology development, human-resource development, and especially extension. These investments have diminished in recent years, and there is urgent need for re-invigoration and for a paradigm shift towards farmer participation - particularly in relation to non-monetary technologies (Singh, 1996).

Thorough *characterization* of production environments is essential in defining appropriate production systems. These defined systems and their technologies shall need to be location-specific and farmer-driven if they are to improve nutritional security of vulnerable rural populations. Improved agricultural technologies shall be key ingredients in raising productivity, competitiveness, and hence nutritional and income security. For the non-irrigated areas, these improved technologies shall feature *watershed* development and water-saving techniques.

Livestock have a major and increasing role in small-holder mixed-farming systems. Towards the objectives of diversified agriculture and of income and nutrition generation,

priorities for livestock-technology development are animal health, nutrition, and reproduction.

To enhance labour productivity on small-holdings, priority needs are *tools* - small, but perhaps mechanized - wherewith drudgery can be lessened but employment maintained. Such tools will add value to the work hours. In *post-harvest* handling, agro-processing, and value-addition activities, the priority intervention is to disseminate more widely various available, proven technologies. These available technologies serve not only to reduce post-harvest losses, but also to improve produce quality through effective storage, packaging, handling, and transport, such that export-quality items can be marketed.

Biotechnology can and should benefit small-holders. However, biotechnological products must be available at affordable prices, and they must be appropriate to the agriculture and the food of the small-holders and the rural poor. Targets for biotechnological development - already being addressed through biotechnological procedures and through conventional methods - are cultivars of small-holder food crops that are resistant to insect pests, diseases, and other biotic stresses, and that are tolerant of drought, waterlogging, soil toxicity, and other abiotic stresses. Such cultivars would not only lessen the costs of production and increase productivity, they would additionally lessen environmental pollution (Singh, 2000).

Globally, genetically-engineered crops are commercially grown on several million hectare, mostly in North America; and in Asia, on some few thousand hectare, mostly in China. For poor people, in India and elsewhere, transgenic cultivars hold promise of cost-effective solutions to human-nutritional deficiencies. Among candidate cultivars are *golden rice* - rich in vitamin A, and others having desirable concentrations of protein, minerals, and amino acids and fatty acids. In the longer term, biotechnology has pro-poor potential (Persley, 2000) to incorporate a nitrogen-fixing ability into cereals, and to enhance products durability following harvest and during storage

Access by small-holders to biotechnology-derived seeds, products, and technologies must be ensured through the WTO/TRIPS Agreement. The world's small-holders are not merely the recipients of technologies developed through formal national and international systems, they are also developers and donors of valuable products and knowledge - particularly in relation to plant and animal genetic resources. These small-holder contributions must be accommodated - and their benefits recognized and compensated - within future developments of TRIPS and of patent regimes.

Co-operative Farming and Farming Co-operatives

India has a long and successful history of farmers' co-operatives, through which small-holders increased their bargaining power as buyers of inputs and sellers of products. Such bargaining power shall become increasingly important as trade globalization expands.

An expansion of the historic role of the farmers' co-operatives is the fore-mentioned creation of large-scale co-operatives that undertake commercial-scale processing - as of milk in Gujarat and of sugarcane in Maharashtra. A feature of these enterprises is their adoption of corporate, professional management. Other sectors of India's agriculture,

and other states, may offer similar opportunities. To the extent that is appropriate, national and state governments - perhaps with private-sector consultants - may support such initiatives through education and advice, and if necessary through development of an enabling administrative environment.

A newer development is the *co-operative group-farming* enterprise, wherein households retain their land-ownership rights, but pool and share their farming resources, operations, and benefits. In appropriate circumstances, such group-farming has potential to transform subsistence agriculture to demand-driven, commercial agriculture, and perhaps to increase rural-community post-harvest enterprise, employment, and income. There is likely to be a strengthening need for the government - through policy and by intervention - to assist and nurture this nascent development.

Globalization shall encourage corporatization of agricultural trading entities. Considering their costs of individual transactions, such entities shall find it uneconomic to trade with small-holders and with small-scale rural enterprises. However, an array of professionally and capably managed large-scale small-holder co-operatives that commanded a large fraction of regional or national output of agricultural commodities and products could ensure that the trading entities find it both essential and profitable to trade with the small-holder sector. Such entities would recognize (as do our Tables 3 and 4) that the small-holder sector shall generate an increasing proportion of national output of most commodities - including higher-value ones. National and state governments would need to ensure an operational environment in which small-holders had a choice among competing co-operatives that sought their custom and membership.

As a crucial socio-economic contribution to rural development - and in their own financial interest - such large-scale private-sector co-operatives should expect to provide insurance, micro-finance, and safety nets to their members, and to provide to them awareness and skills-training for existing and emerging technologies - both for pre- and for post-harvest technologies. Successful co-operatives would - inevitably - generate and conserve on-farm and off-farm rural employment.

In the medium-term - and addressing a crucial national interest - successful large-scale rural co-operatives, with attendant private-sector enterprises, should expect to create rural centres of production and processing. Such centres could prevail against the migratory trend whereby rural poor become urban destitute - with dangerous potential for social and political interest. Investors - public or private - will appreciate that the investment-plus-recurrent cost for a *rural workplace* is substantially less than for an *urban workplace.*

Institutional and Infra-Structural Supports

As previewed in the preceding section, the proposed large-scale rural co-operatives would expect to provide a cost-effective "single-window-delivered" array of technical and financial services. For the *individual* small-holder producers of primary products, the technical services would expect to include custom-hire facilities and operators wherewith to undertake timely and efficient pre- and post-harvest *field-crop*-production activities, and on-farm guidance and assistance in *horticultural* and in *livestock* husbandry. For contiguous small-holdings, *communal* services would include crop- and livestock-marketing support, and irrigation-water supply - in partnership with water-

users' associations where appropriate. It is thus re-confirmed that institutional and initial financial support - from national or/and state agencies - must be provided to the embryonic large-scale co-operatives.

Pending the establishment and functioning of large-scale co-operatives, small-holders shall increasingly require a range of financial services - for micro-scale savings and loans, and for crop and livestock and household-emergencies insurance. In many rural areas - especially remote areas, there shall be need for public-sector strengthening of institutional and infra-structural supports in order to attract the private-sector and the civil-society micro-finance agencies. FAO has extensive expertise and experience in assisting Member Countries - including India - with their micro-banking and rural-credit programmes. This assistance could be expanded - should India so wish - to support the increasing number of rural community-based organizations and self-help groups - especially the women-comprised groups.

FAO has the mandate and expertise to assist also with *long-term* strategies and planning for land-ownership. In the *near-* and *medium-term,* however, and as a powerful contribution to the armoury that must confront India's hunger and poverty, the more-tractable institutional issues of *land-leasing* can perhaps be resolved, and the skills and energies of the land-less and of the sub-marginal-size farm households thereby engaged more fully in the national cause.

Risk Management

For the Indian small-holder, poverty entails not only a meagre-ness of capital resources to invest, but also that any investment from those meagre resources involves a higher risk than would a similar investment by a wealthy farmer. In a rational assessment of a contemplated risk, the assessment depends not only of the balance of potential loss and potential gain, but whether, also, the potential loss is manageable from the assets owned.

Regrettably, there have been all-too-many instances of small-holder suicide as a consequence of excessive loss through mis-fortunate risk taking. The remedies require an institutional and financial environment that lessens risk to small-holder families: perhaps including options for farm-system diversification and for off-farm rural employment, improved access to technologies and their requisite inputs and to information and advice, and available and affordable micro-credit and crop and livestock insurance.

Families dependent on *non-irrigated* small-holdings are additionally vulnerable during seasons of adverse weather. Fortunately, India now has ground-and-satellite-based systems for forecasting medium-term weather and seasonal agricultural output. The greater reliability - compared to heretofore - of these forecasts permits a responsible and actuarial development of crop and livestock insurance products for farmers both of irrigated and of non-irrigated small-holdings.

Additionally, FAO operates a *Global* Information and Early Warning System (GIEWS), which provides information on food production and food security - at global, regional, national, and sub-national scales. It can thereby empower decision makers to take timely action in the event of forecast food shortages. India can link strongly to this system - and also to the complementary Food Inventory and Vulnerability Information and Mapping System (FIVIMS) - and thereby maximise its capability to lessen the risk-exposure of its small-holder and rural-land-less farm families.

X. CONCLUSIONS AND POLICY IMPLICATIONS

India's agricultural economy and food security depend vitally on the small-holder farmers. In relation to their aggregate land-holding, the holdings smaller than 1.0 ha contribute proportionately more (Tables 3, 4, 6) to the national grains production than do the larger holdings. Despite this contribution, the small-holder families, who constitute about one-half of the national population, comprise almost three-fifths (Table 26) of the nation's hungry and poor. As reasoned from Tables 1 and 2, it is socially beneficial to the nation that the number of small-holdings should continue to increase. It is therefore incumbent upon the nation to assist the small-holder families to increase their productivity and to augment their assets and entitlements.

Administrative assistance that might be afforded with relatively little legal complexity would be a liberalization of the land-lease market, relaxation of the constraints to inter-state movement of agricultural produce, and institutional support to new models of agricultural co-operatives.

In the medium- and the longer-term, India will need to negotiate within the *World Trade Organization's* forums and procedures to ensure - perhaps through a *"food-security-box"* facility - that its small-holder agriculture is protected against unfair competition and against excessive fluctuations in international prices for commodities. Correspondingly, India's small-holders shall need to be assisted to trade internationally to exploit their comparative advantages in producing herbal medicines and certified "organically-grown" foods.

Priorities for assistance to small-holders through *technical* supports and interventions are guided by the concerns that - notwithstanding that several effective programmes have generated increased on-farm productivity - crop and livestock yields, and productivity and sustainability of resource use, all remain low, and yield gaps in some regions remain high. Relatedly, it is cautionary to recall that India's rates of increase in total factor productivity - notably for crops - were during the 1990s appreciably less than in preceding decades. This feature is authoritatively attributed to that last decade's substantially lower investment in agriculture and in its supportive research / extension component. Thus, public- and private-sector involvements to optimize the prospective benefits from bio-technology, eco-technology, and informatics, and from integrated / packaged soil-water-irrigation-nutrient-pests management, and from a strengthened research-extension-farmer-market continuum, are likely to prove socially and economically rewarding.

Socio-economic interpretations (from Tables 19 and 21) indicate that ownership of land, however small, and/or a buffalo (and to a lesser extent, a cow) are associated with superior household income, nutrition, and food security. Similarly, Table 28 quantifies an association between head-of-household *education* and poverty. Table 27 indicates that, notwithstanding their increasing productivity, most of the families that operate holdings smaller than 0.5 ha, and many families with holdings of 0.5 - 1.0 ha, and perhaps all of the land-less-farm-labour families, are *net purchasers* of almost all food items. They correspondingly need cash wherewith to make those food purchases, and to augment their assets - including livestock, and to attain an adequate livelihood and to finance their children's education.

These families' options for earning such cash are to sell their unused labour, and/or (if owning land) to intensify, expand, or diversify their more-productive own-farm activities. Thus, in the national interests - including the interest that rural poverty should not be transformed into urban destitution - mechanisms that generate *rural* on-farm, off-farm, and on-off-farm employment, and that include a component of risk-management insurance to complement the Public Distribution System, should be promoted vigorously.

Additionally, rural investment - as in road, transport, water-impoundment, market, information, and communications infrastructures - is cost-effective; and notably so in non-irrigated areas. Correspondingly, rural development and rural-employment generation each require an investment in human resources and in skills strengthening, and in education and other social services. With upgraded infra-structures and strengthened human resources as an attractant, new enterprises and rural-finance agencies would expect to avail quickly of promising operational opportunities. It is thus here pertinent to reiterate that the *cost of a rural workplace* is substantially less than the cost of an urban workplace

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Appendix Table 1: Totals of poor and of under-nourished persons in various farm-size categories: Various years 1980-1998: Rural India only

Year	Sub-marginal	Marginal	Small	Medium	Large	All farms
Number of farm-households (million)						
1980	33.8	16.0	16.1	12.4	10.2	88.5
1983*	34.7	17.1	17.0	12.8	10.0	91.7
1985	35.7	18.2	17.9	13.2	9.8	94.9
1988*	39.8	19.6	19.2	13.6	9.5	101.7
1990	42.7	20.6	20.1	13.8	9.2	106.5
1993*	47.6	22.3	21.5	14.2	8.9	114.5
1998*	54.9	25.3	23.8	14.9	8.6	127.5
Number of persons per farm household (via National Social Survey)						
1983	5.0	5.2	6.0	6.6	7.3	5.7
1988	5.2	6.0	6.9	7.3	8.1	6.2
1993	5.0	5.9	6.6	7.4	8.0	6.0
1998	4.8	5.3	5.7	6.0	6.7	5.3
Total persons in farm-size category (million)						
1983	172.3	89.4	101.3	85.2	73.5	521.8
1988	204.8	117.8	131.5	99.5	76.3	629.9
1993	235.6	130.4	142.4	104.9	71.3	684.7
1998	261.5	132.9	134.9	90.0	57.8	677.1
Total of *poor* persons in farm-size category (million)						
1983	93.0	41.1	41.5	29.8	18.4	223.9
1988	79.9	35.3	30.2	16.9	8.4	170.8
1993	89.5	35.2	27.1	14.7	9.2	175.7
1998	73.2	30.6	24.3	13.5	5.8	147.3
Total of *under-nourished* persons in farm-size category (million)						
1983	77.5	27.7	25.3	17.9	11.0	159.5
1988	59.4	24.7	21.0	13.9	7.6	126.7
1993	75.4	31.3	24.2	12.6	8.6	152.0

* Extrapolated from Agricultural Census data.

Appendix Table 2: Total Factor Productivity: Trends for various crops in selected states

Crop	Trend in Total Factor Productivity		
	Increasing	**No change**	**Declining**
Rice	Andhra Pradesh, Orissa, Punjab, Tamil Nadu, Uttar Pradesh, West Bengal	Assam, Haryana	Bihar, Karnataka, Madha Pradesh
Wheat	Haryana, Punjab, Rajasthan, Uttar Pradesh	Madhya Pradesh	
Sorghum	Andhra Pradesh, Maharashtra, Karnataka	Madhya Pradesh, Rajasthan	
Pear millets Maize	Gujarat, Haryana, Rajasthan Madhya Pradesh	 Rajasthan, Uttar Pradesh	
Barley	Uttar Pradesh	Rajasthan	
Chickpea	Haryana	Rajasthan, Uttar Pradesh	Madhya Pradesh
Black gram	Maharashtra	Andhra Pradesh, Madhya Pradesh, Uttar Pradesh	Orissa
Moong	Madhya Pradesh	Andhra Pradesh , Rajasthan	Orissa
Pigeonpea	Madhya Pradesh	Gujarat, Uttar Pradesh	
Groundnut	Andhra Pradesh , Karnataka, Maharashtra, Orissa	Gujarat, Tamil Nadu	
Rapeseed & Mustard	Rajasthan, Uttar Pradesh	Assam, Haryana	Punjab
Soybean		Madhya Pradesh	
Sugarcane	Bihar	Andhra Pradesh , Haryana, Karnataka, Maharashtra, Uttar Pradesh	
Cotton	Gujarat, Haryana, Tamil Nadu	Andhra Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Punjab	
Jute	Assam, Bihar, West Bengal		Bihar
Onion	Maharashtra	Himachal Pradesh	
Potato	Uttar Pradesh	Himachal Pradesh	

Source: P. Kumar, FAO/RAP, based on costs of cultivation; DES, GOI.

Appendix Table 3: Crops that contributed to rural-poverty reduction: Selected states: 1973-98

State	Poverty-reduction rate (%/ann)	Contributing crops
Andhra Pradesh	5.9	Rice, Sorghum, Groundnut
Assam	2.0	Rice, Jute
Bihar	2.2	Sugarcane
Gujarat	5.0	Cotton, Pearl millet
Haryana	3.0	Wheat, Pearl millet, Cotton, Onion, Chickpea
Karnataka	4.0	Sorghum, Groundnut, Cotton
Madhya Pradesh	2.8	Wheat, Pigeonpea
Maharashtra	3.4	Groundnut, Cotton, Sorghum, Black gram, Onion
Orissa	2.2	Rice, Groundnut
Punjab	5.9	Rice, Wheat
Rajasthan	3.3	Rice, Wheat, Bajra, Rapeseed / Mustard
Tamil Nadu	4.4	Rice, Cotton
Uttar Pradesh	3.0	Rice, Wheat, S'g'rcane, Rapeseed / Mustard, Potato, Barley
West Bengal	3.7	Rice, Jute

Source: Computed from household data in National Sample Surveys (Various Rounds - 1973-1998): All-India surveys on consumer household expenditure, employment, and unemployment.

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