AGRICULTURAL RESEARCH PRIORITIES FOR THE ASIA-PACIFIC REGION – A SYNTHESIS

ASIA-PACIFIC ASSOCIATION OF AGRICULTURAL RESEARCH INSTITUTIONS
FAO REGIONAL OFFICE FOR ASIA AND THE PACIFIC
Bangkok, Thailand

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For copies please write to:
The Executive Secretary
Asia-Pacific Association of Agricultural Research Institutions (APAARI)
FAO Office in India
55, Max Mueller Marg
New Delhi 110 003

Preface

Regional approaches to identify agricultural research and development priorities has received considerable attention in the recent past, through bottom up exercise involving diverse stakeholders such as NARS, IARCs, ARIs, NGOs and other international organizations (FAO, IFAD, GFAR). Such an approach has also been adopted by CGIAR in its vision and strategy, and there has been a growing concern as to how best regional priorities can be matched with international priorities, taking care of the R&D needs of the national systems.

APAARI in its 'Vision 2025' has focused on some of these concerns and highlighted these during its meetings and Expert Consultations. During 2001, it organized three sub-regional meetings on ARD Priority Setting; for West and South Asia at ICRISAT, Patancheru, for Southeast and East Asia at IRRI, Los Baños, Philippines, and for the Pacific region at Nadi, Fiji. The recommendations of these were further discussed at the Expert Consultation in Bangkok during 12-14 November 2001. This exercise while analyzing the regional priorities, took note of the common priorities for the sub-regions and as to how best to integrate these with some of the ten CG Challenge Programmes (CPs) identified recently. It also emphasized that in viewing this, the role of regional networks is also to be examined critically and efforts made to bridge the existing gaps.

Based on the above deliberations, several common areas for research opportunities/regional priorities could be identified namely, natural resource management, genetic resources, commodity chain development, meeting protein needs of growing population, tree and forest management, funding support and cross-cutting activities on: information and communication management and capacity building. Also, within each of these priorities, further specific research areas could be identified.

The publication contains discussion papers on ARD Priorities for the three sub-regions that have undergone extensive revision during the series of meetings and an Expert Consultation. Thus an effort has been made to present the sub-regional ARD needs in as comprehensive manner as possible and it is hoped that the document will prove to be an important input in the process of ARD planning in the region. APAARI remains grateful to Drs Mruthyunjaya and Suresh Pal from India; Dr Patricio S. Faylon, Philippines and Dr R.D. Ghodake, Papua New Guinea who prepared the documents for the sub-regions and remained closely associated with the whole process till the publication of this status report.

(R.S. Paroda)

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Contents

Agricultural Research Priorities for South and West Asia

MRUTHYUNJAYA* AND SURESH PAL**

INTRODUCTION

Asia region still accounts for nearly two-thirds of the chronically undernourished people in the world. South Asia alone is home to about one-third malnourished persons in the world; about one out of every five persons in the region is chronically undernourished. Underweight children below 5 years of age, expressed as a proportion of this age group, is as high as 67 per cent for Bangladesh, 53 per cent for India, and about 38 per cent each for Pakistan and Sri Lanka. The FAO estimates indicate that, by 2010, Asia will still account for about one-half of the world's malnourished population, of which two-thirds will be from South Asia.

Nearly three-fourths of the poor in South Asian countries are concentrated in rural areas and depend on agriculture for food, employment and income. The landless farm workers account for about 40 per cent of rural poverty in Bangladesh and 45 per cent in India. The rest are small and marginal cultivators and tenants. Agriculture and rural development is central to a strategy aimed at alleviating poverty and food insecurity, apart from serving to fuel industrialization. The past three decades of agricultural growth clearly support this view. However, recurring issues on population and problems with demographic transition and natural resource degradation and management appear to be more pressing now than ever before. New challenges are likewise emerging from global developments in trade. Because these have important implications for agricultural development and household food security in the region, it is crucial that they get the attention they deserve.

Modern science is a powerful stimulus to agricultural transformation and economic growth. Through improved technologies, it has been possible to increase food availability per person by almost 20 per cent since the early 1960s. Nevertheless, hunger remains persistent in Asian countries. Further, the yield potential of the green revolution has apparently been exhausted. Given the urgency of averting hunger, new applications of modern science to food and agriculture through research and development (R&D) have to be sustained. New developments in biotechnology and information technology offer higher potential. Public research investments should be more focussed in areas that would not be privately funded and that offer convincing expectations of a positive social payoff. Besides focusing research investments in high potential irrigated areas, giving importance to rainfed areas and fragile agro-ecoregions also assume critical significance.

The NARS in some of the Asian countries are fairly well developed (e.g. India, Pakistan, Sri Lanka). Other countries have also specialized in some crops or resource use. All Asian countries can benefit from information exchange and collaboration in planning and organizing relevant research activities. In South Asia, such collaboration has a great potential because of the large contiguous agro-ecological tracks. Research priorities and funding applicable to one part could be of use to other parts. Further,

* Director, National Centre for Agricultural Economics & Policy Research (NCAP), Pusa, New Delhi-110012, India.
** Senior Scientist (Agric. Economics) NCAP.

in South Asia, cropping patterns are dominated by rice and wheat for which generic research will be useful for large areas in different countries. The advances made in biotechnology, tissue culture, and plant/animal genetics in some of these countries can be made use of by others, rather than reinventing the wheel.

Socio-economic Profile of the Countries

South Asian countries include Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. These countries, in general, have common structures and socio-political institutions. There are marked similarities in their economic, agricultural and governance systems, as well as in their approach to education, health services and welfare activities. However, these countries differ considerably in terms of their size of population, geographical area and economy (Table 1). India is the largest country in the region with about one billion population and 442 billion US dollars of gross domestic product (GDP) in 1999. Population density in the region varies from 981 persons/sq km in Bangladesh to 164 persons/sq km in Nepal. More than two-thirds of the population live in rural areas, and a vast majority of them are illiterate. Exports constitute about 11-22 per cent of the GDP, except Sri Lanka where exports are 36 per cent of the GDP. Foreign direct investment is also nominal in most of the countries, except India where it was US $ 2.6 billion in 1998. Furthermore, external debt as percentage of GDP varies from 20 per cent in India to 41 per cent in Pakistan and Sri Lanka. The World Bank has classified all the South Asian countries as low-income countries with per capita GNP of US $ 755 or less. Real per capita GDP in 1999 (1993 international dollars) varied from 1219 in Nepal to 3056 in Sri Lanka with India and Pakistan occupying a middle position. All these countries have improved their economic performance in 1990s; the average GDP growth rate during 1990s varied from 4 per cent in Pakistan to 6.1 per cent in India. However, much of this growth was negated by the growth in population, resulting in a moderate rate of growth in per capita income. The human development index is also very low in all the countries (Table 1).

Table 1: Basic socio-economic indicators of South and West Asian countries

Indicator	Bangladesh	India	Nepal	Pakistan	Sri Lanka	Iran
Human development index[a] (1998)	0.461 (146)	0.563 (128)	0.474 (144)	0.522 (135)	0.733 (84)	0.709 (97)
Adult illiteracy rate (%, 1998)						
– Males	49	33	43	42	6	18
– Females	71	57	78	71	12	33
Population (million, 1999)	128	998	23	135	19	63
Population density (people/sq. km, 1999)	981	336	164	175	294	39
Urban population (%, 1999)	24	28	12	36	23	61
Gross national product (billion dollars, 1999)	47.0	442.2	5.1	64.0	15.7	110.5
Average annual GDP growth rate (%), 1990-99	4.8	6.1	4.8	4.0	5.3	3.4
Real per capita gross national product (1993 international dollars, 1999)	1,475	2,149	1,219	1,757	3,056	5,163
Exports of goods and services as percentage of GDP (1999)	14	11	22	15	36	14
Foreign direct investment (million dollars, 1998)	308	2,635	12	500	193	24
Share of agriculture in gross domestic product (%, 1999)	21	28	41	26	21	na
External debt as percentage of gross national product	22	20	31	41	41	12
Food production index (1989-91=100)						
– 1979-81	79.2	68.1	65.9	66.4	98.3	61.1
– 1996-98	110.8	119.9	117.2	136.2	109.1	144.7

[a] Number in parentheses is rank out of 174 countries.
Source: World Bank (2001), UNDP (2000)

The estimate of poverty in the region during the early 1990s indicates that a large proportion of the population is living below the poverty line (Table 2). The national poverty line indicates that more than 34 per cent of the population lives below the poverty line. The incidence of poverty is more in rural areas. For instance, rural poverty in Nepal and Bangladesh was more than double of urban poverty. However, urban-rural poverty difference was comparatively small in India[1]. The international poverty line (per cent of population below 1 dollar a day) for the corresponding period indicates a high concentration of poverty in the region. The estimate varies from 6.6 per cent in Sri Lanka to 44 per cent in India. The international poverty line when measured as percentage of population with the expenditure below 2 dollars a day, indicates that more than three-fourths of the population was living below the poverty line, except in Sri Lanka where the poverty level was 45.4 per cent. Table 2 also indicates that a vast majority of children under age 5 are malnourished. Alleviation of poverty and malnutrition therefore will continue to be a major challenge in South Asia.

Economic situation in West Asia is comparatively better than South Asia. For example, in Iran, real per capita GDP in 1999 (1993 international dollars) was 5163 and external debt as percentage of GDP was only 12 per cent. The population density and the proportion of illiterate people are also low (Table 1).

The foregoing discussion indicates that though the countries in South Asia have done reasonably well in general, their progress in alleviating poverty is quite slow. This concern coupled with acceleration of agricultural growth for higher income and food and nutrition security and sustainable management and use of natural resources will continue to influence investment priorities in the region. This paper examines the main development challenges in the region in general and those related with agricultural development in particular. The paper also outlines the role of agricultural research in meeting these challenges. The paper is organized as follows. Next section discusses in brief the agricultural development scenario, followed by organization and intensity of agricultural research in the region. The subsequent two sections deal with characterization of major agro-ecoregions and analysis of commodity priorities. This is followed by identification of major production constraints, growth opportunities and research priorities for different agro-ecoregions. Finally, the paper concludes with some observations on research strategies for addressing the identified research priorities.

Table 2: Incidence of poverty and malnutrition in South Asia

Indicators	Bangladesh	India	Nepal	Pakistan	Sri Lanka
National poverty line					
Survey year	1995/96	1994	1995/96	1991	1990/91
Percentage of population below poverty line					
– Rural	39.8	36.7	44.0	36.9	38.1
– Urban	14.3	30.5	23.0	28.0	28.4
– National	35.6	35.0	42.0	34.0	35.3
International poverty line					
Survey year	1998	1997	1995	1996	1995
Percentage of population below $1 a day	29.1	44.2	37.7	31.0	6.6
Percentage of population below $2 a day	77.8	86.2	82.5	84.7	45.4
Prevalence of child malnutrition					
Percentage of malnourished children under age 5 (1992-98)	56	50	57	38	38

Source: World Bank (2001)

[1] The latest data (1999-2000) indicate a poverty level of 26.1 per cent in India. However, for the sake of comparison with other countries, 1994 data are included.

AGRICULTURAL DEVELOPMENT SCENARIO

Small holders dominate the agriculture in South Asia. There may be exceptions in some regions or sectors where large holdings dominate, e.g., large estate in plantation sector. Importance of agriculture, though central to economic development, is declining over time in relative terms. Prime concern of all the countries in the region was to attain food self-sufficiency, and a number of agricultural development programmes were initiated to achieve this objective. All the countries introduced land reforms such as redistribution of surplus land, ceiling on holdings, protection of tenants, consolidation of holdings, etc. to accelerate agricultural growth. The performance was, however, variable, and the impact was limited by lack of supportive systems like input supply, credit, markets, etc. It is now widely known that because of lack of these supportive systems agricultural growth bypassed resource-poor farmers and regions. For instance, owing to differences in supportive institutions, rice productivity in eastern India is still far below that in northwestern India.

The most important sources of growth in agriculture are non-price factors. Public investments in surface irrigation and development and dissemination of improved technologies contributed largely to agricultural growth, ushering the Green Revolution in the region. HYV technology along with assured supply of fertilizers and water really shifted the production frontier during the 1960s and 1970s. Increase in the productivity because of improved technologies and massive public investment in rural infrastructure including irrigation, encouraged private investment in agriculture. In addition, price incentives in the form of subsidized inputs and remunerative output prices also attracted private investment in agriculture.

More recently, macro economic reforms introduced in some countries like India during 1990s have further accelerated agricultural growth. On the one hand, these reforms encouraged private investment (both domestic and foreign) in infrastructure and supportive system for the provision of inputs (like seed) and other services. On the other hand, the reform process improved incentives in agriculture through better terms of trade, accelerating agricultural growth. Although it is rather premature to establish direct impact of these reforms at this stage, it is believed that the reforms will create a conducive environment for input and knowledge-intensive agriculture.

Resource Use, Productivity and Availability of Foodgrains

In spite of high population pressure and limited or no expansion of arable land, the countries in South Asia have made tremendous progress in terms of achieving self-sufficiency in foodgrain production. As shown in Table 4, cereal production doubled in South Asia during the last three decades, reaching a level of 245 million tonnes in 1999. The production of pulses, however, varied from 12 to 15 million tonnes during the last four decades. Another remarkable achievement, albeit less discussed, is that milk production in the region increased more than three times during the last three decades. As noted earlier, most of these gains were negated by the growth in population. Consequently, annual per capita foodgrain production remained almost stagnant (around 180 kg) during 1960s to 1980s and increased moderately to 197 kg in 1990s. In spite of almost four-fold increase in total milk production, the per capita production increased from 48 kg in 1961 to 80 kg in 1999. Nevertheless, there is marked decline in food imports and the region is self-sufficient in food production.

Another significant achievement on food security front is stabilization of production and prices of foodgrains in the region. It is widely documented that year-to-year fluctuations in foodgrain production have registered a significant decline not only in favourable irrigated environment but also in rainfed regions (Pal *et al.*, 1993 and Pandey *et al.*, 2000). This has significant implications for

food security of the region. In spite of floods, droughts and cyclones, there were few instances of starvation, large imports or food aids. This, coupled with better management of food stocks and integration of domestic market assured availability of food. Foodgrain prices decreased in real terms as well as remained much more stable than the international prices.

Notwithstanding these significant achievements, crop yields are still low in the region – yields of rice (clean) and wheat are less than 3 tonnes/ha. The productivity of agricultural workers is also very low. Level of fertilizer consumption is moderate and barring a few irrigated pockets, extent of farm mechanization is also low. Limited area under irrigation without any further scope of its expansion and declining per capita availability of arable land call for increasing productivity (Table 3).

West Asia also has a more or less similar agricultural development scenario, except that it is favourably placed in respect of population pressure. Rice yield is comparable with that in South Asia, but wheat yield is slightly lower. In this region, agriculture is dominated by livestock, wheat and horticultural crops. The per capita production of foodgrains, which was increasing steadily until 1980s, has decreased slightly in 1990s, but per capita milk production increased to 82 kg in 1999 after stagnating at 72 kg during 1961-1990.

Trend in Food Demand

There are two major changes in food demand: First, there is a noticeable decline in per capita consumption of cereals, particularly coarse cereals, because of decrease in real prices and thereby increase in real income; and second, consumption pattern has become more diversified because of increase in demand for high value products like fruits, vegetables, milk and meat (Paroda and Kumar 2000). These changes have important implications for food and nutritional security. These countries have not only to produce additional food but also diversify food products with higher nutritional value.

Second concern of food security is that the demand for food will increase because of increase in population, income of poor people and feed demand. It is estimated that the demand for foodgrains in South Asia will increase to about 360 million tonnes in 2030, assuming a moderate to high rate of growth in income (3.5 to 5.5 per cent per annum). Depending upon income growth, the demand

Table 3: Agricultural development indicators

Indicator		Bangladesh	India	Nepal	Pakistan	Sri Lanka	Iran
Per cent of land area under permanent crops	1980	2.0	1.8	0.2	0.4	15.9	0.5
	1997	2.5	2.7	0.5	0.7	15.8	1.0
Irrigated land as percentage of crop land	1979-81	17.1	22.8	22.5	72.7	28.3	35.5
	1995-97	43.4	32.4	38.2	80.8	30.7	37.7
Per capita arable land (ha)	1979-81	0.10	0.24	0.16	0.24	0.06	0.36
	1995-97	0.06	0.17	0.13	0.17	0.05	0.29
Tractors per thousand agricultural workers	1979-81	0	2	0	5	4	17
	1995-97	0	6	0	13	2	40
Fertilizer consumption (kg/ha)*	1998	132	93	26	91	116	20
Agricultural productivity (value added	1979-81	212	275	162	394	649	2,570
per agricultural worker (1995 dollars)	1996-98	276	406	189	626	726	4,089
Total cereal production (million tonnes)	1999	24.64	188	4.78	24.45	1.96	13.23
Total pulses production (thousand tonnes)	1999	513	13,550	214	1089	28	489
Total milk production (thousand tonnes)	1999	2,075	77,180	1,143	25,566	295	5,524
Paddy yield (tonne/ha)	1998	2.7	2.9	2.4	2.8	3.2	4.3
Wheat yield (tonne/ha)	1998	2.2	2.6	1.6	2.2	–	1.7

Source: World Bank (2001), FAO (1998) * Computed from FAO data.

Table 4: Trends in foodgrain production and population in South Asia and West Asia (Iran)

Indicator		Bangladesh	Bhutan	India[a]	Nepal	Pakistan	Sri Lanka	South Asia	Iran
Total cereal production[c] (million tonnes)	1961	10.24	0.09	69 [b]	2.30	6.44	0.70	89	3.8
	1970	11.48	0.11	97	2.24	10.91	1.07	119	5.65
	1980	15.13	0.14	119	3.19	15.45	1.50	149	8.57
	1990	19.17	0.10	162	2.84	19.39	1.76	202	12.35
	1999	24.64	0.14	188	4.78	24.45	1.96	245	13.23
Total pulses production (thousand tonnes)	1961	253	0.8	12,700 [b]	85	934	3.9	14977	160
	1970	351	1.3	11,820	111	780	5.4	13069	191
	1980	632	2.3	10,630	139	676	42	12121	225
	1990	512	1.6	14,260	168	1072	54	14077	355
	1999	513	1.6	13,550	214	1089	28	15396	489
Total milk production (thousand tonnes)	1961	915	18	20,375	546	5,998	104	27,957	1,581
	1970	1,065	22	20,800	625	7,445	141	30,098	2,000
	1980	1,162	28	31,560	747	9,014	243	42,753	2,800
	1990	1,593	31	63,678	922	14,723	252	71,200	3,900
	1999	2,075	32	77,180	1,143	25,566	295	106,291	5,525
Total population (million)	1961	53	0.9	452	9	51	10	577	22
	1970	67	1.1	555	11	66	12	712	28
	1980	88	1.3	689	14	85	15	893	39
	1990	109	1.7	851	19	119	17	1,117	56
	1999	127	2.1	998	23	152	19	1,321	67
Per capita production of foodgrains[c] (kg)	1961	198	98	181	265	145	70	179	180
	1970	177	106	196	214	177	89	186	209
	1980	179	110	188	238	190	103	180	225
	1990	181	57	207	159	172	107	195	2227
	1999	198	69	202	217	168	104	197	205
Per capita production of milk (kg)	1961	17	20	45	61	118	10	48	72
	1970	16	20	37	57	113	12	42	71
	1980	13	22	46	53	106	16	48	72
	1990	15	18	75	49	124	15	64	70
	1999	16	15	77	50	168	16	80	82

Source: FAO (2000); [a] Economic survey (various years); [b] data refers to 1960; [c] paddy data were converted into clean rice.

for milk will be in the range of 192-232 million tonnes and that for fruits 110-138 million tonnes. An increase of a similar magnitude is expected in the demand for vegetables, meat, fish and eggs (Table 5). It is important to note that in order to meet this increase in demand, yields of foodgrains should be increased by 50 per cent by 2030. The required increase in yield of other high value commodities and livestock will be in the range of 100-200 per cent depending upon the rate of income growth (Fig. 1). These targets of yield increases are quite challenging.

Sustainability Concerns

The concerns relating to sustainability of agricultural systems are becoming central to the development process. These concerns are studied and explained by a number of researchers in various ways. A widely accepted measure is agricultural total factor productivity (TFP) – productivity of a system by taking all outputs and inputs together. It is observed that there is a deceleration in the growth of TFP in the agriculturally developed (irrigated) regions (Kumar and Rosegrant, 1994; Evenson *et al.,* 1998). It is also observed that a number of constraints like buildup of pests, depleting soil fertility, weeds, etc. are emerging in the irrigated production systems (Fujisaka *et al.,* 1994). The most important concern is relating to sustainable use of natural resources. It is increasingly felt that natural resources – land and water, are depleting fast. Land degradation due to salinity, alkalinity, water-logging, overgrazing and erosion by water and wind is widespread and unabated. Intensification of land use, NPK imbalance,

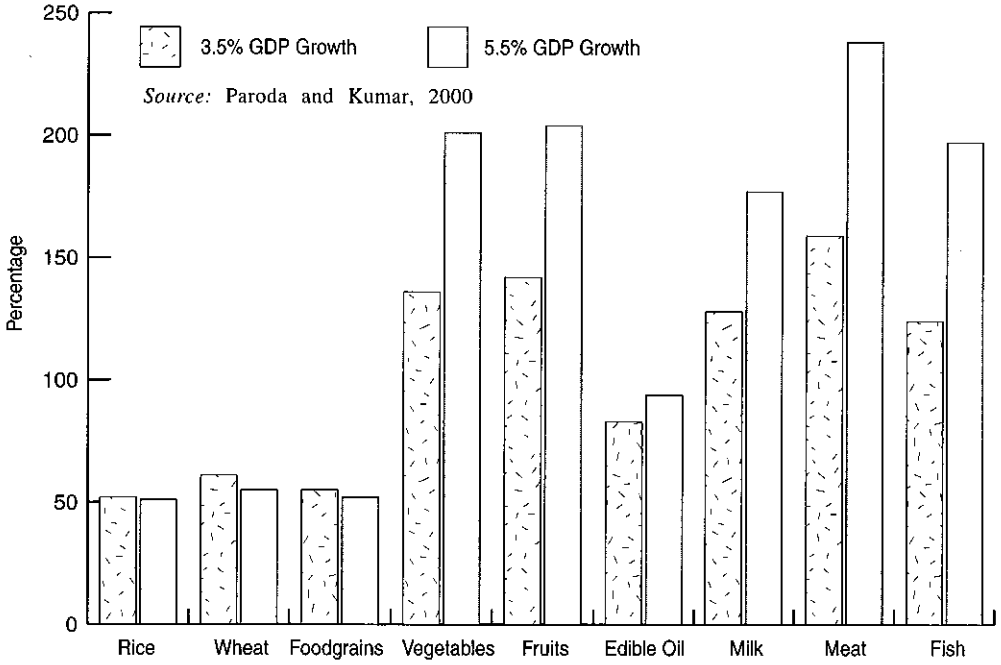


Fig. 1a: *Required increase in yield to meet food demand in 2030 in South Asia*

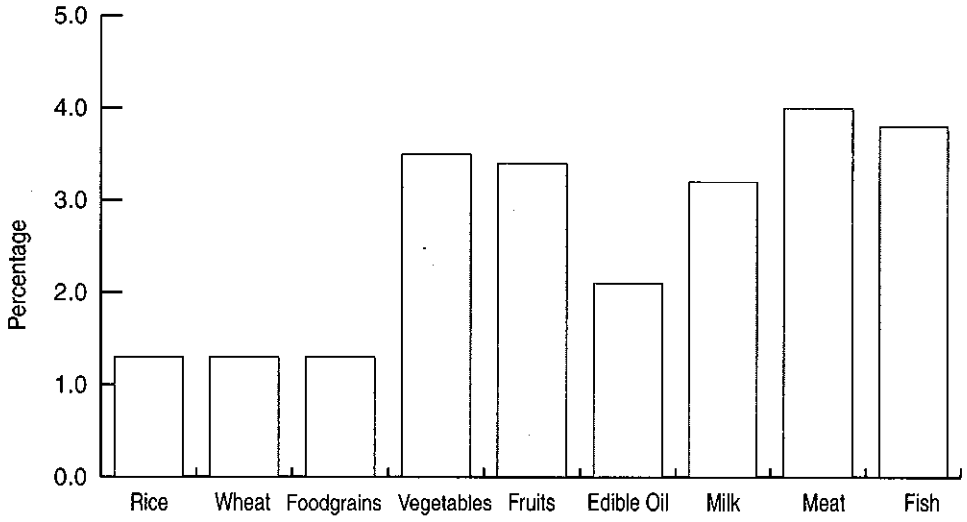


Fig. 1b: *Expected growth (%) in food demand in South Asia, 2000-15*

less application of organic manure, and adverse effect of pesticides on microbial activities in soil, are fast eroding the productive capacity of the land. These sustainability issues need to be addressed, whilst promoting productivity of agricultural systems.

Several studies have pointed out sustainability implications of the rapidly dwindling groundwater resources in South Asia. In a recent study, Seckler *et al.,* (1998) examined the present status and future requirement of groundwater resources (Table 6). It is indicated that most of the groundwater is used for irrigation purposes, and irrigation effectiveness is less than 50 per cent in South Asia. Further, with the current level of irrigation effectiveness, withdrawals of groundwater will increase by 67 per cent in India and 134 per cent in Pakistan in 2025, which could be brought down to 15

Table 5: Projection of food demand (million tonnes) in South Asia in 2030

Food item	Assumption	Bangladesh	India	Nepal	Pakistan	Sri Lanka	South Asia
Rice	3.5% GDP growth	32	114	4.9	6	2.8	161
	5.5% GDP growth	31	114	4.9	6	2.7	160
Wheat	3.5% GDP growth	4	83	1.7	38	1.2	129
	5.5% GDP growth	4	80	1.6	37	1.2	124
Pulses	3.5% GDP growth	1.1	24	0.4	2.0	0.2	28
	5.5% GDP growth	1.1	26	0.5	2.1	0.2	30
Total foodgrains	3.5% GDP growth	38	264	10	50	4.3	366
	5.5% GDP growth	37	260	10	49	4.2	360
Edible oils	3.5% GDP growth	1.0	12	0.2	4.4	0.1	18
	5.5% GDP growth	1.1	13	0.2	4.6	0.1	19
Vegetables	3.5% GDP growth	2.8	151	3.6	9.4	1.4	168
	5.5% GDP growth	3.3	193	4.4	11.3	1.7	215
Fruits	3.5% GDP growth	3.6	84	1.6	18.8	1.4	110
	5.5% GDP growth	4.5	106	2.1	24	1.7	138
Milk	3.5% GDP growth	4.7	130	2.9	52	1.0	192
	5.5% GDP growth	5.7	158	3.6	63	1.3	232
Meat	3.5% GDP growth	0.9	10	0.6	5.1	0.1	17
	5.5% GDP growth	1.2	13	0.8	6.3	0.2	22
Eggs	3.5% GDP growth	0.3	3.5	0.1	0.8	0.1	5
	5.5% GDP growth	0.4	4.7	0.1	1.0	0.2	64
Fish	3.5% GDP growth	2.6	10	0.1	1.1	0.7	15
	5.5% GDP growth	3.4	14	0.1	1.3	0.9	20

Source: Paroda and Kumar (2000).

Table 6: Status and efficiency of groundwater use in South Asia

Country	Bangladesh	India	Nepal	Pakistan	Sri Lanka	Iran
Annual water resources 1990 (km^3)	2357.0	2,085	170.0	418.3	43.2	137.5
Total withdrawals 1990 (km^3)	23.8	518	2.9	155.7	8.7	64.3
Per capita withdrawals 1990						
– Domestic (m^3)	7	18	6	26	10	65
– Industry (m^3)	2	24	2	26	10	22
– Irrigation (m^3)	211	569	143	1226	483	1004
Irrigation effectiveness 1990 (%)	30	40	58	49	36	65
Percentage increase in the withdrawals in 2025 over 1990						
– with current level of irrigation effectiveness	89	67	122	134	51	112
– with 70% irrigation effectiveness	2	15	87	91	-4	100
2025 withdrawals (with 70% irrigation effectiveness) as percentage of annual water resources	1	29	3	71	19	93

Source: Seckler *et al.*, (1998).

and 91 per cent, respectively, if irrigation effectiveness is increased to 70 per cent. With such a marked increase in irrigation effectiveness, India and Pakistan would still withdraw 29 and 71 per cent of their groundwater resources in 2025 respectively. It is important to note that these are average figures for these two countries and situation of groundwater use is alarming even today in semi-arid and arid regions. The situation is equally alarming in West Asia. For example, Iran is expected to use 93 per cent of her water resources in 2025 with an irrigation effectiveness of 70 per cent, which is 5 per cent higher than the existing level. Besides acute shortage, salinity in groundwater is also a serious problem in West Asia, as well as in Pakistan and India.

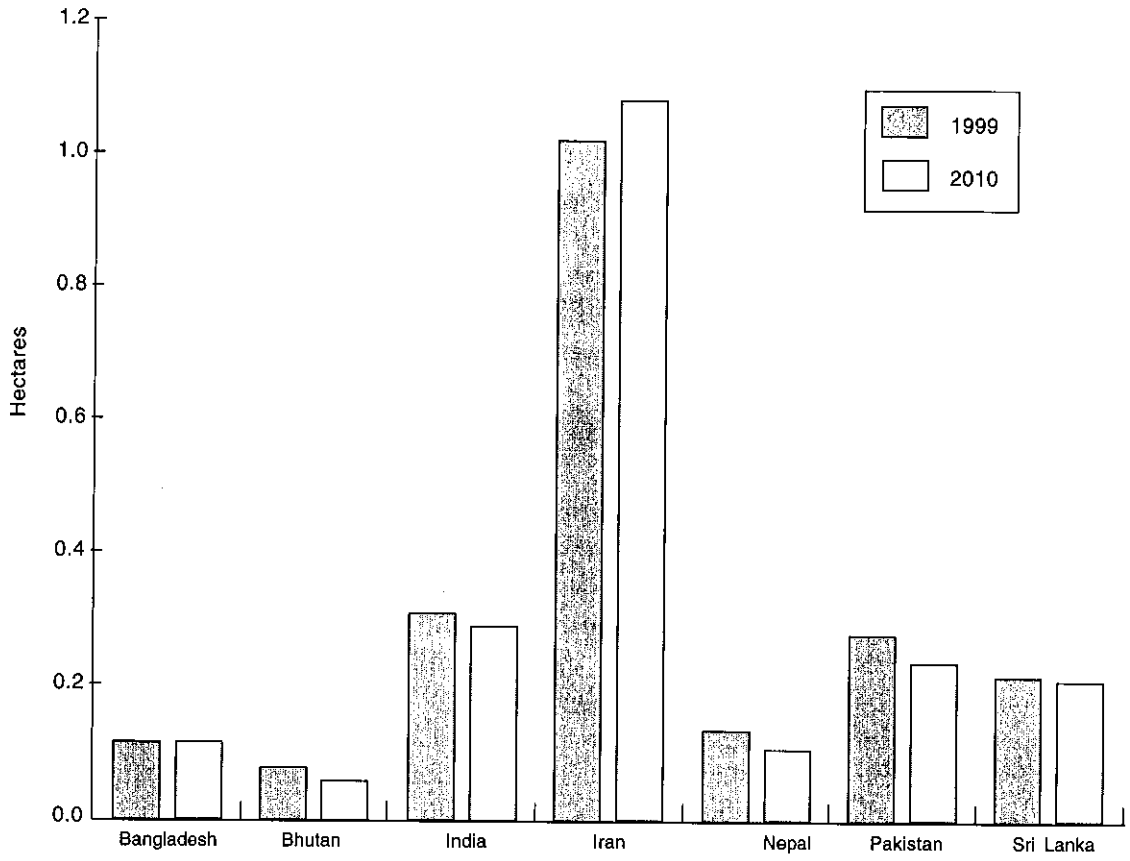


Fig. 2: *Availability of land per person in agriculture*

Agricultural Development Issues

Based on the foregoing discussion, the following development issues can be identified for the region:

Efficient growth: Acceleration of agricultural growth will continue to be a pressing need of the region. It is not only essential to accelerate the rate of growth but also to achieve an efficient growth. Higher growth in agriculture is desirable for food and nutritional security, higher employment and income, whereas improved efficiency of production systems is essential for making agriculture competitive in the wake of trade liberalization. Also, the growth should be diversified in terms of products base and regionally widely spread.

Poverty alleviation: It is now widely accepted that the growth in agriculture, led by technological developments, made significant impact on rural poverty. Given the level of absolute poverty and hunger, need for accelerating agricultural growth will always be there. The growth should be equitable in terms of crops/commodities, regions and class of producers.

Sustainability: The concerns relating to sustainability of agricultural systems are becoming increasingly important and visible, and these concerns primarily deal with inter-generational equity in use of natural resources and protection of environment. It is necessary that the productivity level should be enhanced and sustained over time. At the same time, natural resources and environment should be protected for their sustainable use by future generations. Given the widespread degradation of land, water, and genetic and other environmental resources, sustainability of the agricultural system will be central to all development programmes in the region.

In addition, there could be a number of other developmental issues, such as export promotion, gender equity, system diversification, self-reliance, etc. Agricultural research will be expected to contribute to these development objectives in South Asia[2]. In West Asia, however, focus will be more on sustainable use of natural resources, besides agricultural growth.

As we have entered into the 21st century, we are dealing with a knowledge society. Science holds the key for development. For the countries in the region, it is critical to utilize the benefits of the new science and technology for the socio-economic development, particularly for alleviating rural poverty. Many of the rural poor depend on agriculture for employment and income. Accelerated agricultural growth offers a potential source of poverty reduction. Agricultural research should therefore play a central role in this task.

Agricultural Research

Intensity and organization of research: The intensity of agricultural research, measured as number of scientists with at least a master's degree or research expenditure as percentage of AgGDP, varied considerably. India has the largest agricultural research system in the region employing about twenty-two thousand scientists (Box 1) and spending slightly less than 0.5 per cent of AgGDP on agricultural research and education. Research intensity is further low in other countries, spending less than 0.3 per cent of AgGDP on agricultural research and education. This is much smaller than what is spent by all the developing countries on an average (0.5 per cent) and certainly much smaller than that spent by the developed countries (2.5 per cent). Unlike the developed countries, most of agricultural research in this region is conducted by public research organizations.

Box 1: Number of scientists in public agricultural research organizations

Country	Number of scientists
South Asia	
Bangladesh	2224
India	22,249
Nepal	236
Pakistan	3461
Sri Lanka	484
West Asia	
Iran	2997

Note: Data provided by research council of the respective countries and includes scientists with master's degree or above.

The organization of agricultural research is quite similar in all the South Asian countries. There are central as well as provincial research organizations, particularly in large countries like India and Pakistan. There are institutes dealing with research as well as agricultural universities for education and research. At the centre, there is a council to plan, coordinate and conduct agricultural research, education and frontline extension (transfer and refinement of new technologies). The Indian Council of Agricultural Research (ICAR) is the largest and oldest organization in the region.

Major research thrusts: Over the years, public research organizations have successfully addressed research needs of their respective countries. As noted earlier, in the beginning the main objective of the system was attainment of food self-sufficiency, which has now expanded with the addition of other objectives of equitable growth, sustainability of production systems, diversification of product-mix, export promotion, etc. In terms of commodity coverage, focus has slowly expanded from crop research to livestock, horticulture, fisheries, forestry and natural resources. A similar expansion is observed in the disciplines of agricultural sciences, and currently the focus is on agricultural biotechnology.

[2] All these concerns are explicitly considered by the NARSs in developing their research plans (PARC, ICAR (not dated); BARC; 2001

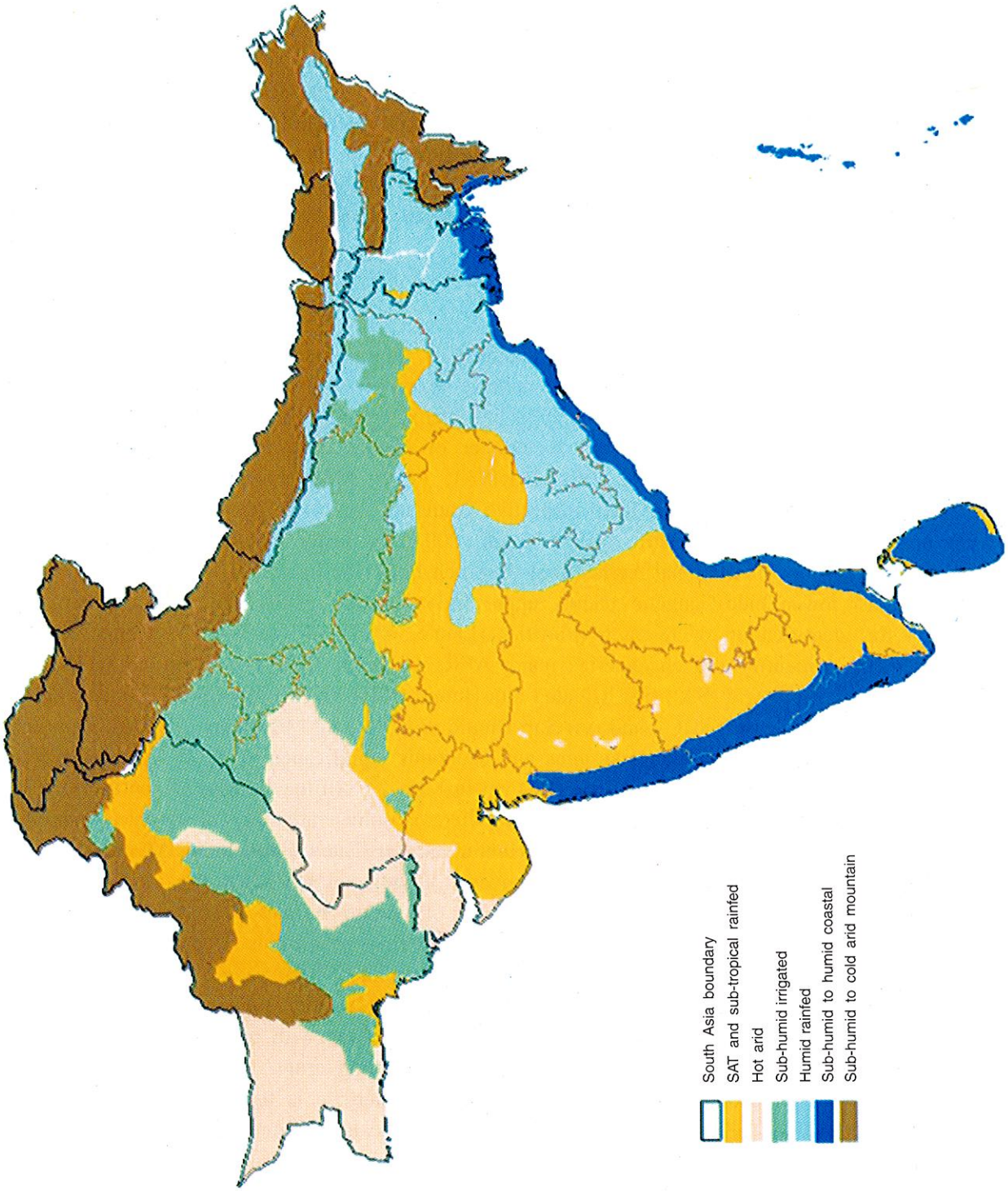
Need for research prioritization: The need for prioritization of agricultural research arises because of three reasons. First, there is considerable expansion of research agenda, and providers of research, making allocation of research resources difficult. Conventional approaches for resource allocation are inadequate, and therefore, use of formal and systematic approach of research prioritization requiring more information and analysis is warranted. The new approach assesses objectively the impacts of alternative research activities in terms of attainment of research objectives. Secondly, research intensity is very low and therefore it is essential to use available resources judiciously for maximizing research benefits. Also, research prioritization helps improve the efficiency of the system. Lastly, donors can easily support research programmes if these are identified in a consultative bottom up approach. Keeping this objective in view, subsequent part of this paper is developed.

AGRO-ECOREGIONS FOR RESEARCH PLANNING

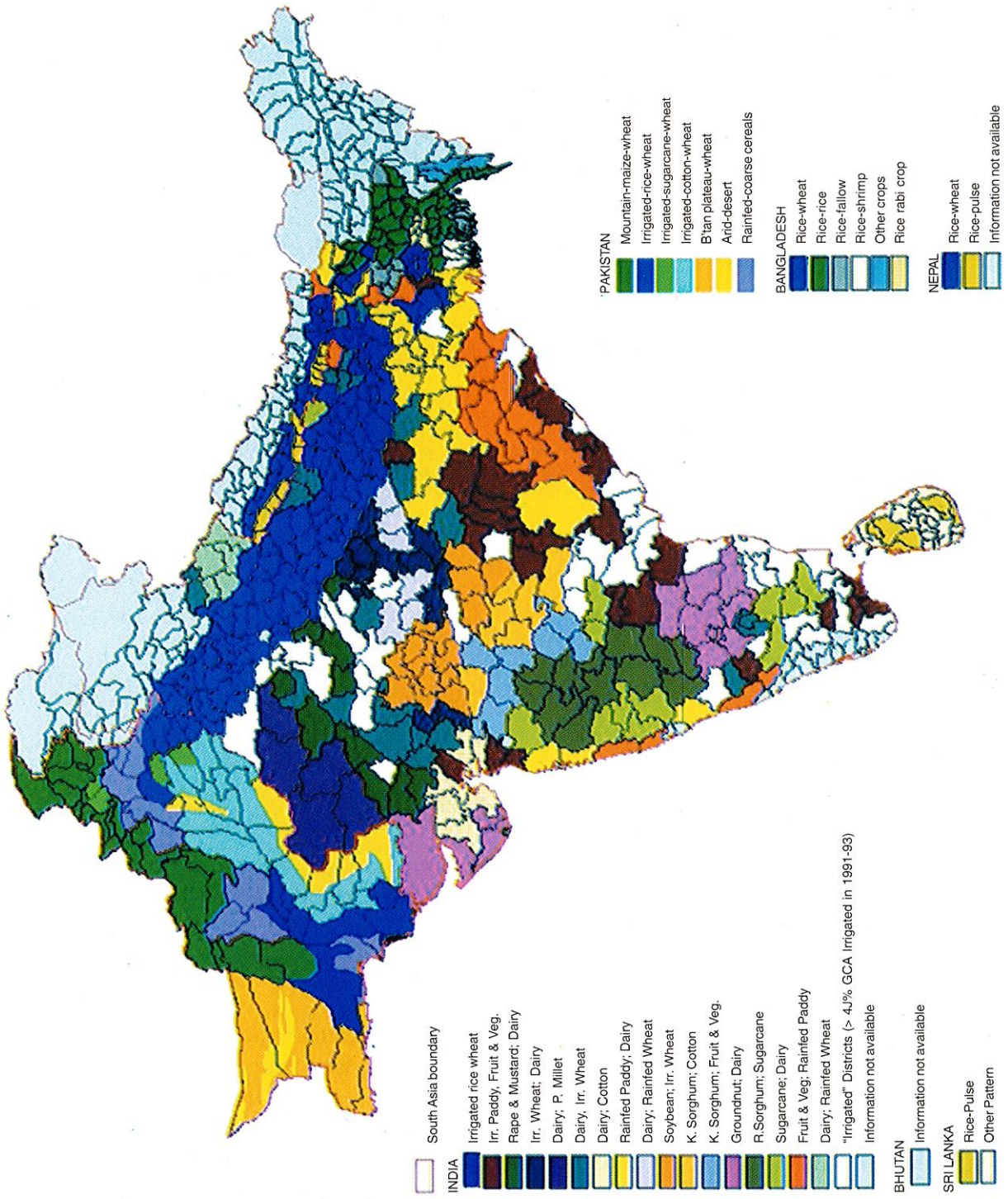
Delineation and Characterization

South Asia: Agro-ecoregional basis of research planning is getting increasing acceptance all over the globe, as it helps target research efforts and achieve economies of scale through integration of research efforts. This approach requires identification and characterization of various ecoregions based on agro-climatic and socio-economic factors[3]. A number of studies have identified agro-ecoregions (AERs) in the South Asia (Sehgal *et al.,* 1992; ICRISAT, 1999). More recently, ICAR, PARC and NARC have identified major AERs for their respective countries for better identification of research investment priorities (PARC (not dated); Saxena *et al.,* 2001; D. Joshy (NARC)[4]). The Centres of the Consultative Group on International Agricultural Research (CGIAR) have also identified four broad regions (mountains, lower Indo-Gangetic plains, upper Indo-Gangetic plains and semi-arid regions) in South Asia for identification of research priorities (Lenne, 2001). We used this information and our own judgement to identify and characterize major AERs of South Asia. The identified AERs are: (i) Hot Arid (HA); (ii) Semi-Arid (SA); (iii) Irrigated Sub-Humid (ISH); (iv) High Rainfall Humid (HRH); (v) Sub-Humid to Humid Coasts (SHC); and (vi) Sub-Humid to Cold Arid Mountains (SCAM). Regional spread, soil type, climate, major cropping systems and economic significance of these AERs are given in Table 7. Geographical spread of these AERs is shown in Map 1[5]. All these AERs are fairly uniform, except the rainfed humid and mountain regions where there is some variability in climate, soil type and irrigated area. The Semi-Arid, High Rainfall Humid, and Irrigated Sub-Humid AERs are quite large, occupying 38.1, 26.4 and 19 per cent, respectively, of the total net sown area in South Asia. They contribute about one-fourth each to the total value of output. It may be noted here that the High Rainfall Humid AER largely practicing rice-based production systems, is of greater significance as it has a lot of potential for further growth, and a large proportion of poor people live in this region. The Irrigated Sub-Humid system practices rice-wheat, cotton-wheat and sugarcane-wheat cropping systems. Both canal and tubewell irrigation are intensively used, along with other modern inputs like fertilizers. Livestock is important in all the systems, but horticultural crops are widely grown in the Semi-Arid and the Coastal ecoregions. Another important characteristic is that except Arid and part of the Irrigated ecoregions, all other ecoregions receive significant amount of precipitation which can be conserved and used for agriculture. The estimates of poverty by agro-ecoregion are not readily

[3] The terms of agro-ecoregion and agro-ecosystem are used interchangeably in this paper.
[4] Personal communication.
[5] Thanks are due to U.K. Deb (ICRISAT) for help in producing the map.



Map 1: *Agro-ecoregions of South Asia*



***Map 2:** Cropping Pattern of South Asia*

Table 7: Important agro-ecoregions of South Asia and their characteristics

Particular	Hot Arid Agro-ecoregion	Semi-Arid Agro-ecoregion	Irrigated Sub-Humid Agro-ecoregion	High Rainfall Humid Agro-ecoregion	Sub-Humid to Humid Coastal Agro-ecoregion	Sub-Humid to Cold Arid Mountain Agro-ecoregion
Regional coverage	Desert of India and Pakistan; arid and plateau region of Baluchistan in Pakistan	Rainfed peninsular and west India; rainfed region of Pakistan Punjab and Sindh; part of Sri Lanka	Irrigated region of north-west India (upper Indo-Gangetic Plains) and irrigated region of Pakistan (Punjab and Sindh); part of *tarai* region of Nepal	Eastern India (irrigated or lower Indo-Gangetic region, and rainfed or eastern Plateau region); Bangladesh; part of *tarai* region of Nepal	Coastal regions of India and Bangladesh; part of Sri Lanka; Maldives	Hill and mountain region of India, Nepal and Pakistan; Bhutan
Dominant Soil type	Desert soils; plateau	Loamy; black and red soils	Alluvium-derived soils	Alluvium-derived soils; red and yellow soils; lateritic soils	Loamy deltaic-alluvial, red and lateritic soils	Brown forest and podzolic soils; sandy to loamy skeletal soils
Climate	Hot arid	Hot semi-arid	Hot-semi arid; hot sub-humid	Hot sub-humid to per-humid	Hot semi-arid to per humid	Cold arid; warm sub-humid to per-humid
Rainfall (mm)	<300	500-1000	500-1200	1000-2000	900-3200	<150-4000
Dominant cropping systems	Millets, pulses and oilseed-based	Coarse cereal-pulse-based; cotton-based; oilseed-based; rice and sugarcane-based in irrigated areas	Rice-wheat; sugarcane-wheat; cotton-wheat; maize-wheat	Rice-rice; rice-wheat; rainfed rice-based; rice-vegetables; rice-fish; fruits	Rice-coconut-based; plantation crops; fruits; brackishwater shrimp and fish	Millets and wheat in cold arid; rice, coarse cereals and wheat-based
Share in the total net sown area (%)	7.3	38.1	19.0	26.4	5.8	3.4
Share in total value of agricultural production (%)	2.91	25.40	28.59	26.63	10.36	6.11

Source: Based on information provided in Sehgal *et al.*, (1992) and PARC

available, but considering the administrative regions covered under various agro-ecoregions it can easily be seen that most of the poor people are concentrated in the High Rainfall Humid, Semi Arid and Mountain agro-ecoregions. These systems are also characterized by low productivity and vulnerability of natural resources for degradation. These considerations are expected to have significant bearing on research priorities to a large extent.

West Asia: Paucity of data does not permit for a precise delineation and characterization of agro-ecoregions in West Asia. However, it can be generalized that a large part of the region falls under arid and semi-arid conditions. Owing to variations in altitude, rainfall, temperature and irrigation conditions, the region can be classified into irrigated, dryland, rangeland and desert agro-ecoregions. The irrigated and dryland systems cover only a small proportion of the area, but contribute significantly to the total agricultural production. For example, in Iran, the irrigated system covers only 7.8 million ha area, as against 10.7 million ha under dryland and 90 million ha under pastures or rangelands. But most of the production of cereals, commercial crops and horticultural crops is contributed by the irrigated system. Rangelands largely support livestock of nomads and rural people (Keshavarz, 2001).

AGRO-ECOREGION AND COMMODITY PRIORITIES

Methodology and Data

Studies on research priority setting have used five methods, singly, or in combination. These are congruence (weighted criteria) model, economic surplus model/benefit-cost analysis, mathematical programming, econometric models and simulation model. The scoring model can also be applied at micro-level for prioritization of research projects. Choice of the model is influenced by the level of priority setting (macro or micro) and availability of data, analytical skills and resources. We have applied the modified congruence model because of its ease of application in a situation where time and data are binding constraints. Stated simply, the congruence model allocates research resources in proportion to the relative value of production by region or commodity. It implicitly assumes that opportunities for research are equal across commodities, and that the value of new knowledge generated by research is proportional to the value of output. The analysis is based on present values and assumes constancy of relative shares. These restrictive assumptions imply that results of this exercise provide only a starting point in rationalizing research resource allocation. The CGIAR (1992) and the Indian agricultural research system (Jha *et al.*, 1995) also applied this approach because of its simplicity, transparency and flexibility.

Prioritization of commodities and regions involves calculation of an initial baseline matrix consisting of value of output from different commodities in different regions. A composite baseline is then developed using value of output (efficiency), number of poor people (equity), arable land (sustainability) indicators using equal weights for these three parameters (Box 2). These parameters capture extensity dimensions. Initial priority determination based on extensity parameters was modified by using intensity parameters, *viz.* growth in AgGDP, per capita income, extent of groundwater withdrawals and number of scientists in the national system (for detailed methodology, refer CGIAR (1992) Jha *et al.* (1995). Since data for these modifiers by agro-ecoregions are not available, research prioritization between agro-ecoregions was done using extensity parameters only. We have used our judgement to identify and specify the parameters for prioritization and weighting schemes, on the basis of information provided by the NARSs. The value of production was computed using international prices adjusted for freight charges. Freight charges were added to the international prices under importable hypothesis and these were subtracted under exportable hypothesis. Transport cost within the region could not be considered because of non-availability of data. For internationally non-traded commodities, domestic prices of larger-producing country(ies) were taken after converting into US dollars. For this purpose exchange rates reported by the International Monetary Fund were used. Necessary data for this exercise were taken from FAOSTAT and other published sources[6] for the period 1997 to 1999, and the analysis is based on the triennium average.

Box 2. Criteria for research prioritization

Objective	Extensity parameter	Intensity parameter
Efficiency	Value of agricultural output	Growth in AgGDP
Sustainability	Arable land	Extent of groundwater withdrawal
Equity	Number of poor people	Per capita income

Agro-ecoregion and Commodity Priorities

The modified congruence model gives priorities by commodities and agro-ecoregions. This priority matrix can be used to arrive at different priority dimensions, such as AER priorities (sum over

[6] Research councils in the region also provided some information, which is acknowledged with thanks.

commodities by AER), commodity priorities (sum over AERs by commodity) or commodity group priorities for the region (sum over commodities and AERs). In this exercise, AER priorities, and commodity priorities within and across AER are discussed. For the benefit of national programmes, commodity priorities by countries are also presented. Priority score is the share of a commodity/group or AER/country in 100 (per cent), and therefore, higher a score higher is the priority. The national systems can use the priority matrix for allocation of resources across commodities or AERs. Donors can also use the priority matrix to track priority AER and commody or *vice versa*. Since identification of research priorities is the major objective of this exercise, we shall focus on AER and commodity priorities.

Figure 3 shows the AER priorities in South Asia. As noted earlier, the ISH, SA and HRH are the three top priority AERs in South Asia. Efficiency objective can be better addressed on focusing on ISH and HRH, but for poverty alleviation HRH and SA are more important. Sustainability issues are equally important in these AERs, although factors affecting sustainability may vary. For example, it could be depletion of groundwater and soil nutrients in the ISH, whereas soil erosion due to water may be more important for the other two. Among the three smaller AERs, the SHC and SCAM are more important from the point of view of productivity and poverty.

Priority commodity groups (among 91 commodities) in South Asia (Tables 8 and 9) are cereals, livestock, horticultural crops and plantation crops in that order. Cereals are more important in all the AERs, but their priority score is 41 and 51 in the ISH and HRH ecoregions, respectively. Livestock is important in all the AERs, but it gets very high priority score in the HA (41) and SCAM (29). Whereas fruits, cash crops and plantation crops are priority commodities for the SA, ISH and SHC systems, respectively. These priority scores are obtained using importable hypothesis for foodgrains, cotton and sugar, as these are not regularly exported from South Asia. For the commodities with regular exports, such as jute, rubber, tea, coffee, etc. exportable hypothesis was used. In the second scenario, exportable hypothesis was also considered for foodgrains, cotton and sugar. Results of both the

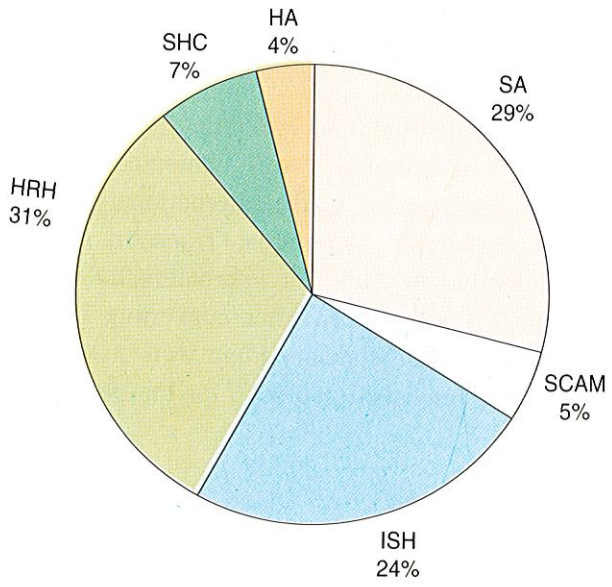


Fig. 3: *Agro-ecoregion priorities in South Asia*

scenarios (Fig. 4) show only marginal change in the priority scores. The priority score of cereals and cash crops decreased marginally under the exportable hypothesis, while it improved for livestock. But considering substantial increase in demand for food in South Asia and its implications on food insecurity (Pinstrup-Andersen *et al.*, 1997; Paroda and Kumar, 2000), we subsequently discuss results of the importable hypothesis for these commodities.

Priority scores of individual commodities as given by the modified congruence approach were used to classify commodities into high, medium and low priority commodities separately for each of the AERs (Table 10). Commodities not covered in this table are of very low priority (score less than 2). As seen from Table 10, except the HA, rice is a high priority commodity in all the AERs, while wheat is a high priority commodity in the HA and ISH, and of moderate priority in the SCAM and the HRH. Small ruminants, oilseeds and pulses are of high priority in the HA and SA, whereas milch animals are of high priority in all the AERs, except the SHC. Except banana in the SA and SHC, all fruits, in general, are of low priority in all the AERs.

Table 11 gives commodity priorities for West Asia, which are similar to those obtained for the HA ecoregion of South Asia. Livestock ranked first with a priority score of 51, followed by cereals (19), fruits (13) and vegetables (12). Among individual commodities, priority commodities are wheat, barley, tomato, grapes, poultry, small ruminants and cow milk. Besides these commodities, orange, pistachio, rice and dates are also priority commodities for Iran perhaps because of diversity of production systems and availability of irrigation in some parts. Orange is a priority commodity for Iran, Iraq and Syria. Cotton is widely grown in Syria and therefore gets high priority score (14).

Table 8: Priority score of commodity groups in South Asia

Commodity groups	Bangladesh	Bhutan	India	Maldives	Nepal	Pakistan	Sri Lanka	South Asia
Cereals	60.4	22.2	35.2	0.0	55.4	21.9	20.3	35.04
	(11.1)	(0.1)	(76.4)	(0.0)	(2.7)	(9.3)	(0.5)	(100)
Roots & tubers	2.0	4.2	2.7	0.0	4.9	0.6	1.4	2.39
	(5.5)	(0.2)	(86.6)	(0.0)	(3.5)	(3.8)	(0.5)	(100)
Pulses	2.0	0.0	5.1	0.0	3.3	2.2	0.2	4.40
	(3.0)	(0.0)	(88.4)	(0.0)	(1.3)	(7.3)	(0.0)	(100)
Oilseeds	1.4	0.2	5.8	0.0	0.4	1.0	0.2	4.63
	(1.9)	(0.0)	(94.8)	(0.0)	(0.1)	(3.1)	(0.0)	(100)
Vegetables	1.2	8.5	6.1	0.0	0.0	2.6	4.7	5.15
	(1.5)	(0.2)	(90.0)	(0.0)	(0.0)	(7.6)	(0.7)	(100)
Fresh fruits	4.8	39.7	10.0	1.7	2.5	7.3	17.8	9.19
	(3.3)	(0.5)	(82.4)	(0.0)	(0.5)	(11.8)	(1.5)	(100)
Dry fruits	0.0	0.0	0.1	0.0	0.0	1.9	0.2	0.38
	(0.0)	(0.0)	(25.7)	(0.0)	(0.0)	(73.9)	(0.4)	(100)
Cash crops	5.1	0.4	9.9	0.0	2.4	18.7	1.1	10.68
	(3.1)	(0.0)	(70.5)	(0.0)	(0.4)	(25.9)	(0.1)	(100)
Livestock	14.1	24.7	17.6	0.0	26.0	40.4	8.9	20.86
	(4.4)	(0.1)	(64.3)	(0.0)	(2.1)	(28.7)	(0.3)	(100)
Plantation	3.0	0.0	5.2	0.0	1.2	1.8	39.5	4.75
	(4.1)	(0.0)	(83.3)	(0.0)	(0.4)	(5.7)	(6.5)	(100)
Fish	5.8	0.2	2.3	98.3	3.9	1.6	5.6	2.53
	(14.9)	(0.0)	(70.7)	(0.5)	(2.6)	(9.5)	(1.8)	(100)
All commodities	100	100	100	100	100	100	100	100
	(6.4)	(0.1)	(76.1)	(0.0)	(1.7)	(14.8)	(0.8)	(100)

Note: Figures in parentheses are priorities of a commodity group across countries.

Table 9: Priority score of commodities by agro-ecoregions in South Asia

Commodity group	Hot Arid Agro-ecoregion	Semi-Arid Agro-ecoregion	Sub-Humid to Cold Arid Mountain Agro-ecoregion	Irrigated Sub-Humid Agro-ecoregion	High Rainfall Humid Agro-ecoregion	Sub-Humid to Humid Coastal Agro-ecoregion	South Asia
Cereals	18.3	20.0	24.6	41.1	50.7	25.9	35.05
	(1.52)	(14.52)	(4.29)	(33.52)	(38.52)	(7.64)	(100)
Roots & tubers	0.7	2.1	3.8	2.0	3.7	0.3	2.40
	(0.89)	(22.55)	(9.62)	(24.39)	(41.41)	(1.13)	(100)
Pulses	6.9	9.7	0.4	3.2	2.5	1.1	4.39
	(4.56)	(55.84)	(0.57)	(21.09)	(15.24)	(2.70)	(100)
Oilseeds	10.8	8.1	0.8	4.5	2.1	3.8	4.65
	(6.78)	(44.37)	(1.06)	(27.48)	(11.94	(8.37)	(100)
Vegetables	4.2	4.8	4.4	3.7	7.2	5.7	5.19
	(2.32)	(23.45)	(5.21)	(20.52)	(37.09)	(11.40)	(100)
Fresh fruits	5.8	14.9	8.9	5.7	5.3	17.1	9.29
	(1.82)	(40.65)	(5.87)	(17.48)	(15.16)	(19.02)	(100)
Dry fruits	6.3	0.0	1.3	0.0	0.0	0.9	0.36
	(51.71)	(0.00)	(22.97)	(0.04)	(0.00)	(25.27)	(100)
Cash crops	1.5	12.7	1.5	18.2	5.5	4.6	10.51
	(0.40)	(30.70	(0.85)	(49.50)	(14.04)	(4.51)	(100)
Livestock	40.7	21.7	29.2	19.3	19.5	12.0	20.44
	(5.78)	(26.99)	(8.73)	(27.02)	(25.39)	(6.09)	(100)
Plantation	0.4	4.3	24.2	1.2	1.1	18.4	5.11
	(0.24)	(21.28)	(28.96)	(6.73)	(5.49)	(37.30)	(100)
Fish	4.3	1.7	0.9	1.0	2.4	10.3	2.60
	(4.86)	(16.34)	(2.14)	(11.29)	(24.18)	(41.19)	(100)
	100	100	100	100	100	100	100

Note: Figures in parentheses are priorities of a commodity group across agro-ecoregions.

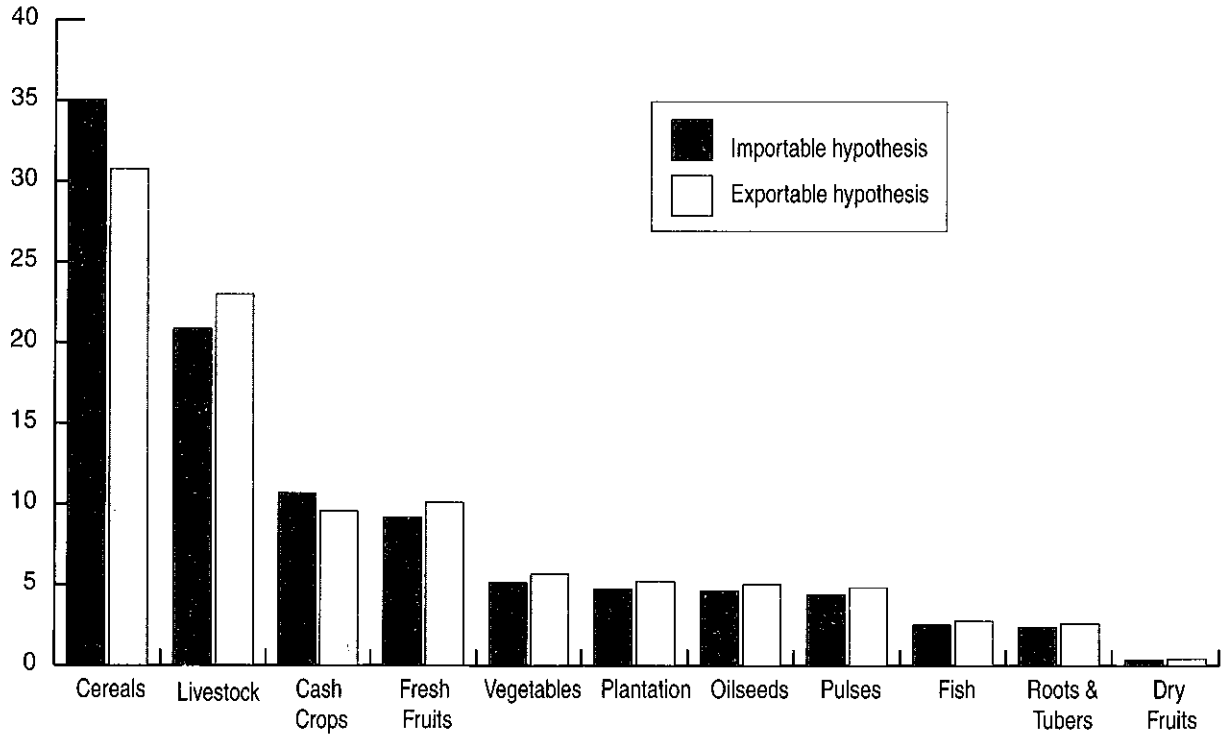


Fig. 4: Commodity priority score in South Asia

Table 10: Priority status of commodities by agro-ecoregion in South Asia

Agro-ecoregion	High priority (priority score >7)	Medium priority (priority score 4 to 7)	Low priority (priority score 2 to 4)
Hot Arid Agro-ecoregion	Wheat, millets, cattle, buffalo, goat	Chickpea, rapeseed, dates, sheep	Rice, inland fish, poultry
Semi-Arid Agro-ecoregion	Banana, rice, cattle, buffalo	Chickpea, groundnut, cotton, sugarcane, tobacco	Sorghum, beans, orange, pulses, mango, poultry
Sub-Humid to Cold Arid Mountain Agro-ecoregion	Rice, tea, cattle	Wheat, maize, buffalo, sheep, goat	Potato, apple, tobacco, poultry
Irrigated Sub-Humid Agro-ecoregion	Rice, wheat, cotton, sugarcane, buffalo	Cattle	Rapeseed, potato, orange, goat
High Rainfall Humid Agro-ecoregion	Rice, cattle	Wheat,	Potato, banana, sugarcane, jute, inland fish, buffalo, goat, poultry
Sub-Humid to Humid Coastal Agro-ecoregion	Rice, banana, tea, marine fish	Coffee, rubber	Coconut, mango, sugarcane, buffalo, poultry, cattle
South Asia	Rice, wheat, cattle	Banana, cotton, sugarcane, buffalo	Tea, tobacco, potato, chickpea, poultry, goat
West Asia	Wheat, poultry, sheep	Cattle, goat	Barley, tomato, grapes

Table 11: Priority score of commodity groups in West Asia

Commodity group	Iran	Afghanistan	Iraq	Saudi Arabia	Syria	West Asia
Cereals	18.2	35.1	21.6	17.9	18.7	19.2
	(13.7)	(11.0)	(4.3)	(66.5)	(4.5)	(100)
Roots & tubers	2.2	1.3	2.3	1.5	0.9	1.6
	(20.5)	(4.9)	(5.6)	(66.5)	(2.6)	(100)
Pulses	1.4	0.7	0.8	0.1	2.1	0.5
	(43.9)	(9.1)	(6.8)	(19.9)	(20.3)	(100)
Oilseeds	0.3	1.2	1.9	0.1	0.4	0.3
	(16.3)	(25.8	(25.9)	(25.3)	(6.7)	(100)
Vegetables	8.4	2.8	23.0	13.0	6.3	11.8
	(10.3)	(1.4)	(7.3)	(78.5)	(2.5)	(100)
Fresh fruits	20.2	9.9	23.6	8.2	13.2	10.8
	(26.9)	(5.5)	(8.2)	(53.8)	(5.6)	(100)
Dry fruits	12.7	1.7	0.2	0.0	7.5	2.3
	(80.0)	(4.6)	(0.3)	(0.0)	(15.1)	(100)
Cash crops	3.2	2.1	1.0	0.0	14.7	1.3
	(35.1)	(9.6)	(3.0)	(0.0)	(52.2)	(100)
Livestock	30.4	45.1	24.0	58.0	34.1	50.8
	(8.6)	(5.3)	(1.8)	(81.1)	(3.1)	(100)
Plantation	1.9	0.0	0.6	0.0	1.9	0.4
	(71.4)	(0.0)	(5.9)	(0.0)	(22.7)	(100)
Fish	1.2	0.0	1.0	1.2	0.2	1.0
	(15.9)	(0.2)	(3.5)	(79.5)	(0.9)	(100)
All commodities	100	100	100	100	100	100
	(14.4)	(6.0)	(3.8)	(71.1)	(4.6)	(100)

Note: Figures in parentheses are priorities of a commodity group across countries.

Futuristic Considerations: Sensitivity Analysis

The modified congruence analysis, which assumes constancy of relative shares of commodities or agro-ecoregions, can be a starting point for research prioritization. But the results need to be adjusted for expected changes arising from unfolding of growth opportunities, research capacity and challenges of globalization. But consideration of these changes requires additional data and analysis. We have considered the growth opportunities by modification of baseline priorities with the growth in AgGDP. A similar modification of the baseline with number of agricultural scientists is also attempted to capture research capability of the NARSs[7]. However, major changes are expected to arise because of trade liberalization; these could be income and price effects affecting food demand, and effect on trade depending upon competitive advantage. These effects are of greater consequence and hence must be incorporated in the analysis and the result should be examined for their sensitivity. However, implications of competitive advantage on agricultural research can be best captured at micro-level (research programme and projects) research prioritization, and therefore, these are considered in the next section. Incorporation of changes in demand for commodities at the macro-level (commodity or ecoregion) is important because ensuring food security is one of the main objectives of NARSs in the region.

Empirical studies indicate significant changes in the demand for agricultural commodities (Pinstrup-Andersen *et al.*, 1997; Paroda and Kumar, 2000). The demand projections for foodgrains include food as well as feed demand. Expected changes in the demand are likely to effect prices and output of commodities and therefore this can be best captured by modification of the value of production (VOP). The VOP of a commodity was adjusted with the expected growth in its demand in the region (Fig. 1b). Since research and extension lag is about 8-11 years (Davis *et al.*, 1987), the growth was extrapolated over a period of 10 years[8]. This adjustment in the VOP implies that the commodities with higher expected growth in the demand should get high priority.

The adjusted VOP thus obtained along with the parameters of sustainability and equity was used for another iteration of the analysis. The results, given in Table 12, indicate that there is a noticeable increase in priority score of horticultural and livestock commodities, whereas cereals registered a significant decline in their priority score in South Asia[9]. Cash and plantation crops also showed moderate decrease in their priority score, while other commodities showed no significant change. It is important to mention here that these results are indicative in nature and some degree of scientific judgement is required to capture other external factors and opportunities (including chances of research success) in setting research priorities.

PRODUCTION CONSTRAINTS AND GROWTH OPPORTUNITIES[10]

Production Constraints

Having identified ecoregion and commodity priorities, the next logical step is to translate these commodity priorities into research programme. This needs identification and prioritization of production constraints (for priority commodities or production systems), growth opportunities and

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[7] These modifications are done for the country-level analysis and not for the agro-ecoregion level.

[8] 1 Y_0 (1+r)t where Y_0 is VOP in the base year, r is expected growth in the demand and t is time period.

[9] Sensitivity analysis could not be done for West Asia because of non-availability of information on expected changes in the demand for agricultural commodities.

[10] This and the next section broadly summarize recommendations of the sub-groups formed during the expert consultations.

Table 12: Sensitivity analysis of commodity priorities for South Asia

Commodity group	Base Scenario	Priorities with VOP adjusted with growth in the demand
Cereals	35.05	31.56
Roots & tubers	2.40	2.36
Pulses	4.39	4.25
Oilseeds	4.65	4.52
Vegetables	5.19	6.76
Fresh fruits	9.29	10.17
Dry fruits	0.36	0.41
Cash crops	10.51	10.08
Livestock	20.44	23.48
Plantation	5.11	4.60
Fish	2.60	2.91

scientific feasibility. The survey of available studies on the topic gives a fairly good understanding of generic production constraints in the various AERs (Table 13). These production constraints are further classified into three categories: (a) natural resource-related constraints, (b) other technical constraints, and (c) socio-economic constraints (Annexure 1). Inadequacy of data does not permit us to analyse relative importance of these three types of constraints, but as felt by participants of the expert consultation and reported in some studies, these constraints cause significant production losses. For example, abiotic stresses like drought and submergence caused significant production losses in rice in eastern India (Evenson *et al.*, 1996). Decreasing profits because of high capitalization of production systems and depletion of natural resources, particularly groundwater are serious binding constraints in the ISH ecoregion. Production environment is becoming more hostile in the Arid and Semi-Arid ecoregions and opportunities for employment and income growth are less. Diversity of production systems, low infrastructure development and technology penetration, lack of markets, labour migration, etc. are major constraints to development of hill and mountain agriculture. Livestock, which is important to smallholders and landless labourers for generation of employment and income in all the ecoregions, is constrained by a number of factors, such as poor nutrition due to non-availability of feed and fodder, high incidences of diseases and less developed markets and other infrastructure facilities (Devendra *et al.*, 2000). Production losses due to socio-economic constraints in all the ecoregions and sub-sectors of agriculture are also significant but difficult to estimate. A systematic strategy to address all these constraints successfully through harnessing scientific opportunities should guide further prioritization of research programmes for various AERs.

Growth Opportunities

Assessment of growth opportunities through application of science is a difficult task, but some judgement can be made using demand side considerations, clients' needs and scientific opportunities (Table 13). There are a number of areas having tremendous growth potential and filling technology gap in these areas would help tap these potentials. The potential of value addition in agricultural products through agro-processing has not received due attention in South Asia. Given the extent of post-harvest losses, particularly in fruits, vegetables and other perishables, scope for value addition, income and employment generation and their likely impact on poverty alleviation would be substantial. However, this requires close collaboration with private sector, investment in infrastructure and an understanding of consumer preferences. Similarly, forestry and agro-forestry offers immense possibilities for growth with sustainable development. On account of paucity of information, it was difficult to make detailed

Table 13: Major production systems, problems and opportunities by agro-ecoregion

Particulars	Hot Arid, Semi-Arid, and West Asia Agro-ecoregions	Irrigated Sub-Humid Agro-ecoregion	High Rainfall Humid; and Sub-Humid to Humid Coastal Agro-ecoregions	Sub-Humid to Cold Arid Mountain Agro-ecoregion
Production Systems	Coarse cereals-based; cotton-based; oilseed (groundnut and soybean)-based; rice and sugarcane-based in irrigated areas; livestock; horticultural crops	Rice-wheat; cotton-wheat; sugarcane-wheat; maize-wheat; buffalo for home dairy; commercial meat and dairy	*Unfavourable, rainfed, flooded:* Rice-pulses/oilseeds/minor grains; rice-jute; rice-fish/ freshwater prawn; *Favourable irrigated:* Rice-rice; rice-wheat; rice-vegetables; rice-fish; horticultural and plantation crops; brackishwater shrimp and fish; open water culture-based fishery; crop-livestock systems (Bengal goat)	*Low (3000-5000 feet) and mid (5000-8000 feet) heights:* Rice-wheat; rice-potato; maize-potato; horticultural crops; trees (fodder and fuel); cattle, buffalo, sheep, goat, poultry *Upper (>8000 feet) heights:* Sheep, goat, horticulture forestry, medicinal plants
Characteristics and constraints	• Risky environment • Erratic and scanty rainfall • Drought prone • High incidence of poverty • Land degradation, salinization and deterioration of soil health • Low productivity and high yield losses • Lack of opportunities for income generation	• High productivity but low profitability of cereal systems • High and overcapitalized mechanization • High levels of input use but low input use efficiency • Relatively low levels of agro-ecoregion diversity • Salt affected areas • Groundwater depletion, soil erosion and exhaustion of past sources of productivity growth (varieties, fertilizers)	• Low level of productivity and large yield gaps • Excess and deficit water regimes, and contamination of arsenic • Soil degradation & erosion • Biotic and abiotic stresses • Poor infrastructure and transfer of technology • Fragmented small holdings • Undeveloped markets, low industrialization • High incidence of poverty • Prone to natural disasters-drought, flood, cyclones, rise in sea level	• Diverse production systems because of differences in altitude, slope, soil, etc. • Poor infrastructure and low technology transfer • Water–excess and deficit • Soil erosion and loss of biodiversity • Deforestation • High post-harvest losses • Jhum cultivation • High incidence of poverty and labour migration
Opportunities	• Diversification of systems • Soil and water management • Market integration • Biotechnology tools and integrated pest management (IPM) for control of biotic stresses	• Diversification of systems-livestock • Soil and water management-zero tillage • Precision farming • IPM • Market integration	• High rainfall, water management • Diversified systems • Dry season cereals (boro rice) • Aquatic system development • Market integration • Biotechnology tools and IPM for control of biotic stresses • Livestock development	• Post-harvest processing and value addition • Potential for off-season vegetables, fruits and plantation crops • Aquaculture, bee keeping, floriculture and seed production • Livestock • Ecotourism

Source: Based on and literature survey and discussion during the workshop

analysis and articulate opportunities in this area in this document. However, rehabilitation of forests, protection of biodiversity and environment, interactions between forestry and agriculture, market development for non-timber and minor forest products, agro-forestry development, etc. were considered to be high impact areas. Another growth opportunity could be management of rainwater in water deficit areas such as the arid and semi-arid ecoregions. There is a need for further refinement and management of technologies and approaches for harvesting and use of water like watershed management. Adoption of these technologies requires group or community action and therefore better

understanding of community action will facilitate rapid adoption of these technologies. Diversification towards employment and income generating activities like livestock and horticulture requires adequate technological and infrastructural support. In particular, their linkages with crop sector should be properly understood and exploited for complementarity. Advances in molecular biology and biotechnology can help in identification and utilization of tolerance to various abiotic and biotic stresses, besides improvements in shelf life and quality of products. Biotechnology can also play a significant role in organic farming. Also, with application of these tools it is possible to reduce research and technology development lag in the development of improved varieties and breeds, as well as to increase chances of research success. However, utilization of these frontier sciences and information intensive technologies needs higher capital investment, inter-institutional linkages, effective regulatory mechanism and delivery system. Diversification of systems through livestock, fishery, bee keeping and horticulture, ably integrated with marketing system will offer uncommon opportunities in the region.

RESEARCH PRIORITIES AND STRATEGY

Research Priorities

At this stage, no formal research prioritization technique was applied to identify the system-specific research priorities. The priorities are consensus judgements of the expert groups. The groups have, however, used systematic process and objective criteria to arrive at these priorities, i) root cause analysis was done for major production constraints and emerging research issues were examined along with research gaps and opportunities, ii) the emerging issues were further subjected to their likely impact on improving efficiency and sustainability of production systems and alleviating food insecurity and poverty, iii) comparative advantage of the region and chances of research success or scientific feasibility were also considered to arrive at the priority research themes.

The identified priorities for various agro-ecoregions in South and West Asia are given in Table 14. These are very broad and depending upon the specific requirement, one may further rework on these priorities and develop executable and locally relevant research programmes. In other words, donors may find these generic priority areas adequate to channel research grants, but individual organizations of the NARSs in the region may further fine tune them for developing their own focussed research agenda. It is clear from these priorities that research agenda is much more complex and broadened now. Conservation of natural resources (land and water, and biodiversity germplasm) is extremely important and the priority AERs are the Arid, Semi-arid, and Irrigated sub-humid. Research issues relating to the rice-based production systems in the HRH region assumes high priority because of its likely impact on poverty alleviation. Socio-economic research issues relating to efficient organization of production including agro-processing, sustainable use of resources, risk management, transfer of technologies and integration of markets are extremely important for all the AERs.

Another way to look at these research priorities is to arrange them by sectors (Table 15). Most of these research priorities are also common for West Asia, but considering significant differences in agro-climatic conditions, it is important to highlight research priorities for this region separately. The most crucial factor in West Asia is to improve water use efficiency. Management and sustainable use of salt-affected soils, and use of saline and poor quality water for crop production also deserve high priority for research. Systematic research efforts on rehabilitation and management of rangelands, integrated farming systems for dryland areas, agro-forestry, and livestock nutrition are also expected to make significant contribution to agriculture, particularly practiced by poor peasants. Crop research should specifically focus on genetic engineering for stress tolerance, wheat cultivars resistant to various

Table 14: Agricultural research priorities by agro-ecoregion in South Asia and West Asia

Hot Arid; Semi-Arid ecoregions of South Asia, and West Asia	High Rainfall Humid; and Sub-Humid to Humid Coastal Agro-ecoregions
1. ***Water management and water use efficiency*** • Improved water harvesting and watershed management • Drought escape and resistant crops; short duration, water efficient crops • Improved water use efficiency (sprinkler, fertigation) and pricing policy 2. ***Diversification of income sources*** • Diversification of agriculture (crop, livestock, fishery, horticulture, agro-forestry) • Introduction of high value crops • Post-harvest processing and value addition • Dual purpose crops (food & quality fodder, feed) • Small scale mechanization • Solar and wind energy utilization for cost reduction 3. ***Soil Health and Fertility*** • Incorporation of legumes in cropping systems • Breeding cultivars for efficient nutrient use • Integrated nutrient management including organic recycling 4. ***Markets and Policy*** • Policies to promote access of poor small holders to markets • Role of private sector in marketing • Identify new markets for products • Market intelligence (information) • Risk management 5. ***Low Productivity Needing Effective Technology Development and Dissemination*** • Seed and resource management technology delivery systems • Quality and value addition through genetic improvement • Biotechnology to reduce yield losses • Thrust on hybrid research • IPM systems for important crops 6. ***Land Use Planning*** • Land use policy • Integrated planning for soil, water, crop-livestock management • Institutions for conflict management among land users • Develop and apply GIS techniques for land use planning • Insurance and early warning systems	1. ***Genetic Improvement*** • Conservation and utilization of biodiversity • Abiotic and biotic stress tolerance varieties • Nutrition improvement 2. ***Diversification*** • Short-duration rice and wheat (to incorporate other crops) • Establishment of legumes and oilseeds in the system • Incorporation of coconuts and bananas in small farm systems • Vegetables, tubers, flowers and other horticultural crops • Farming systems involving crops and animals [cattle, buffalo, goat (black Bengal goat), poultry and fish] • Incorporating winter maize in the cropping system • Rice based farming • Rice fallows to be used for pulses, groundnut, lentil, soybean 3. ***Improving Competitiveness*** • Improving production, quality and processing efficiencies • Post-production management, drying, storage and marketing • Low energy input rural/community-based processing and storage technology • Establishment of cooperative village industries • Market development in the context of new trade regimes • Rural credit supply • Risk management 4. ***Water Management*** • Promoting water users associations • Pricing – for efficient resource allocation • Water use efficiency through crop management, efficiency of inputs in integrated farming and popularizing concepts of IPM, INM, IWM 5. ***Soil Management*** • Zero tillage and small farm mechanization • Soil amendment • Coastal reforestation and mangrove rehabilitation/restoration • Species and systems that promote natural resources management 6. ***Aquaculture and Aquatic Systems Management: Inland*** • Polyculture (composite culture) of finfish in pond systems-genetic diversity and feeding and health care for more intensive culture of fish and crustaceans • Deepwater rice-fish/freshwater prawns • Integrated fish farming • Open water culture-based fishery ***Coastal Aquaculture*** • Marine shrimp farming – sustainability improvement • Health management; feed and nutrition using farm-made, low-cost formulations; resource efficient hatchery and seed distribution systems; pond effluent management • Crab culture and ornamental fish

Note: Research themes and priority areas for the Hot Arid, Semi-Arid ecoregion of South Asia and West Asia are in order of their priority ranking.

Table 14: contd.

Table 14: contd.

Irrigated Sub-Humid Agro-ecoregion	Sub-Humid to Cold Arid Mountain Agro-ecoregion
1. ***Water use efficiency*** • Water user associations to foster – Equitable use within systems – Canal maintenance – Pricing • Practices for plot level water use efficiency – Land levelling implements, training – Aerobic rice varieties for rice-wheat system – Alternative rice establishment practices – Wet-dry irrigation practices – Zero tillage in wheat – Drip and sprinkler irrigation 2. ***Control of soil degradation*** • Reclamation of sodic lands • More diverse crop rotations, including those with legumes, sugarcane, fodder crops to improve land quality • Alternative household fuel sources to allow farm yard manure to be used for soil improvement • Leaf color charts to improve nitrogen use efficiency • Zero tillage for timely sowing to improve nitrogen use efficiency 3. ***Control of pests and weeds*** • IPM in rice, cotton and sugarcane systems • Host plant resistance for crop biotic stresses • Zero tillage and bed system for integrated weed management strategies for *Phalaris* control in wheat systems • More diverse agro-ecosystem for natural management of pests, diseases and weeds 4. ***Post-harvest management*** • Varieties with high quality • Straw treatment and management • Improved threshing implements 5. ***Increasing crop yields*** • Crop varieties for higher yield potential • Improve input use efficiency, stress on precision farming 6. ***Diversification of the systems*** • Incorporation of legumes in the rice-wheat system • Focus on commercial livestock and horticulture sectors • Small scale mechanization • Mechanization of rice plantation	1. ***Common issues*** • Conservation of soil and water • Conservation and utilization of biodiversity • Animal health and management • Post-hervest processing and management • Strengthening research system and capacity • Issues relating to empowerment of women, labour migration and market integration • Conservation and improvement of forestry • Cold water fish culture • Strengthening of seed system • Ecotourism 2. ***Low height (3000-5000 feet)*** • IPM in crops • Off-season vegetables and mushroom production • Small farm mechanization • Promote agroforestry and bee keeping 3. ***Mid heights (5000-8000 feet)*** • Improvement of horticulture and orchards- IPM, INM, root stock and plant propagation • Improvement of medicinal and aromatic plants • Promote agroforestry, bee keeping and tea plantation 4. ***Upper heights (>8000 feet)*** • Conservation and use of medicinal plants • Tropical fruits • Improvement of horticulture and orchards- IPM, INM, root stock and plant propagation • Packaging of fruits • Develop sheep and rabbit farming

Source: Recommendations of the working groups made during the workshop.

strains of rust and IPM in cereals and legumes. This region has limited capacity for agricultural research, and therefore, concerted efforts are required to strengthen research capacity in terms of development of infrastructure and human capital.

Box 3 summarizes the overarching priorities common to all the stakeholders. The broader priorities pertain to five important themes, i) assessment of poverty in the region is a matter of concern for all. Intensive efforts to study the poverty, its mapping and assessment of nature of interventions and investment priorities are to be made, ii) management and sustainable use of natural resources (biodiversity, land and water) is another important priority area for all the agro-ecoregions. Efforts are needed to assess and map the nature and extent of degradation of these resources. The study of technological and institutional interventions for sustainable use of natural resources is also important.

Table 15: Agricultural research priorities by sector

Sector	Priority research themes
1. Crops	1. Crop varieties for • tolerance to abiotic and biotic stresses • Improving crop yield ceilings in irrigated areas • Better product quality, nutrition and value addition • Dual purpose (food and fodder) crops 2. Short duration varieties of rice and wheat to incorporate other crops, especially legumes in cropping systems 3. Diversifying the production systems 4. Improving input use efficiency through ICM, IPM, INM, precision farming etc. 5. Improving cropping systems for higher yields, pest management, natural resource conservation, and integration with livestock and trees 6. Sustainable seed and technology transfer systems 7. Small farm mechanization
2. Horticulture	1. Post-harvest handling, value addition through processing and storage 2. IPM and INM in orchards, vegetables and floriculture 3. Improving root stocks and rapid plant propagation methods in fruit trees 4. Integrated management for off-season vegetables, flowers and peri-urban cultivation 5. Varieties for better quality, nutrition, shelf-life and suitable for processing 6. Protected cultivation of vegetables and flowers 7. Development of arid (hot and cold) horticulture
3. Livestock including poultry	1. Technological options for sustainable crop-livestock systems 2. Improving nutrition through • Quality of crop residues and removing anti-nutritional factors • Strategic supplementation • Improved varieties of fodder crops and feed balance 3. Animal health • Epidemiology, diagnosis and vaccine production of major diseases based on biotechnology • Disease-nutrition interactions • Genetic resistance to major diseases 4. Characterization and improvement of local breeds through selective breeding 5. Factors influencing adoption and impact of improved technologies 6. Market development, product processing and biosafety of products with focus on smallholders 7. Socio-economic and environmental impact of crop-livestock systems, including pastoral systems.
4. Fisheries	***Coastal*** 1. Sustainable management of coastal systems and marine protected areas 2. Sustainable management of marine shrimp farming (feed, nutrition, health and seed distribution), including effluent management 3. Crab culture and ornamental fish ***Inland*** 4. Genetic improvement for growth enhancement and disease resistance 5. Fish health management, particularly for intensive culture of fish and crustaceans 6. Deepwater rice-fish/freshwater prawn 7. Integrated fish farming, and open water culture-based fishery 8. Cold fish water culture ***General*** 9. Post-harvest issues, and biosafety of seafood products 10. Socio-economic issues, environmental impact analysis and institutional issues of aquatic resources and aquaculture
5. Forestry	1. Sustainable management of second-growth forests 2. Inventorying, evaluation and development of forest resources 3. Tree and forest health management 4. Promotion and management of agro-forestry 5. Improvement of medicinal and aromatic plants 6. Market development for non-timber and minor forest products 7. Policy and institutional issues in management of forests 8. Ecotourism and landscape forestry

Table 15: contd.

Table 15: contd.

Sector	Priority research themes
6. Natural resource management	1. Conservation of genetic (crop, livestock, fish, tree), water and land resources 2. Improving efficiency in distribution and use of irrigation water (policy, technology and institutional issues) 3. Technological and institutional options for harvesting and use of rainwater (e.g. watershed management) 4. Sustainable land use, organic recycling and soil fertility management 5. Reclamation of degraded/sodic lands, control/management of saline and arsenic contaminated water
7. Socio-economics	1. Poverty mapping and investment priorities 2. Market integration and trade liberalization with focus on smallholders 3. Risk management 4. Empowerment of women and labor migration 5. Policy and institutional aspects of agricultural R&D

Source: Recommendations of working groups formed during the expert consultations.

Box 3. Areas of common interest and partnership

Research area	Priority agro-ecoregion	Partnership
Poverty mapping and investment priorities	Semi-Arid; High Rainfall Humid; Sub-Humid to Cold Arid Mountains	NARS (Public), IARCs
Improving water use efficiency	All ecoregions of South Asia; and West Asia	NARS (Public and non-profit private), IARCs
Reclamation/management and use of salt-affected soils and saline water	Irrigated and Coastal ecoregions of South Asia; and West Asia	NARS (public) and IARCs
System Diversification	Hot Arid, Semi-Arid ecoregions	NARS (Public and private), IARCs
Animal health and nutrition	All ecoregions of South Asia; and West Asia	NARS, IARCs, private
Commercialization and post-harvest processing	All ecoregions of South Asia	NARS (Public and private), IARCs
Market integration and trade liberalization	All ecoregions of South Asia	NARS (Public), private sector, IARCs
Sustainable seed and technology systems	All ecoregions of South Asia	NARS (Public and private), IARCs
Risk management	Hot Arid; Semi-Arid; High Rainfall Humid; Humid Coastal; and West Asia	NARS (Public), IARCs

Both of these research areas are of 'public good' nature and therefore public research organizations at national and international levels may have to pool their resources to address these research issues, iii) livestock, horticulture and fishery sectors, which have shown significant growth in the recent past, are yet to be fully developed. Concerted research efforts on these areas will diversify the sources of income and employment in the region, and can contribute to alleviation of poverty. It may be noted here that these sub-sectors are important in all the AERs, and therefore, a significant amount of economies of scale in research can be realized. Also, private sector can be a useful ally in the R&D in these areas, iv) studies on commercialization of agriculture and integration of markets would help the countries to compete in the world market, v) a good amount of efforts are needed to study the institutional arrangements for improving farmers' access to technologies, seeds, credit, market, etc. Also, there is need for assessing appropriate institutional arrangements for reducing the impact of risk. Involvement of private sector (profit as well as non-profit) for these purposes and its linkages with public organizations need to be considered under an institutional perspective.

Research Strategy

The strategy should focus on accelerating agricultural development through proper mix of technology, organization and policy options. Efficient organization of production systems and substitution of

knowledge for capital should be the governing forces. Given the intensity of agricultural research in South and West Asia, it is indispensable to organize research efforts efficiently and realize potential synergies through inter-institutional collaboration based on the principle of comparative advantages. This also implies establishing effective working linkages with private R&D organizations. The CGIAR accords high priority to South Asia and stresses on regional integration of research efforts through research partnership. The CG Centres can act as facilitators, collaborators and advocates and can bring together NARSs for partnership in strategic research areas. There are a number of research networks like Cereals and Legumes Asia Network (CLAN), Network of Aquaculture Centres in Asia-Pacific (NACA) and Tropical Asian Maize Network (TAMNET), Rice-Wheat Consortium (RWC), and Underutilized Tropical Fruits Asia Network (UTFANET), operating in the region. This approach needs to be strengthened and replicated. The NARS-NARS collaboration would be useful in a number of commodities like commercial and plantation crops, where international research efforts are negligible.

There is also a need for change in research approach, particularly in national research programmes. The paradigm shift underscores interdisciplinary research in a system perspective. This may require change in research planning and implementation, as most of the research organizations in the NARSs are established, funded and managed on commodity basis. Research-extension-farmer linkages have been a perennial problem, in spite of several changes introduced in the system. But these linkages are critical in research for management of natural resources. Fostering links with farmers is not only useful for articulating research needs, but also for assessment, refinement and transfer of technologies. Experiences gained from farmer participatory plant breeding programmes can be used to strengthen linkages with farmers. All such changes in research approach require greater inputs from social sciences, responsive research management and effective research evaluation mechanisms.

In terms of research methodology, there are significant scientific advancements which need to be harnessed for greater effectiveness and efficiency of research systems. Application of molecular biology tools for control of yield losses due to biotic and abiotic stresses, reduction in post-harvest losses, shortening R&D lag, maintaining animal health and improving product quality holds immense potential. Other promising advancements are IPM, IPNM, ICM, watershed management and precision farming, which are in early phase of their adoption. There is a need for tailoring these technologies to specific research target domains, as some of these technologies may involve commodity (in case of IPM and IPNM) or location (in watershed) specificity. Since these technologies are significantly different from the Green Revolution technologies (technologies embedded in seed, fertilizer and other inputs), institutional mechanisms for technology transfer need to be revamped. The dissemination of specialized information (such as soil fertility, resource management methods, etc. should also be emphasized, besides transfer of technologies embedded in inputs and imparting skills). In this regard, application of information communication technology (ICT) assumes greater significance.

Engineering of NARSs including manpower planning, human resource development, decentralization and research-extension-farmer linkages is central to improving research efficiency. Growth oriented responsive management includes organization and management reforms relating to research infrastructure, research prioritization, monitoring and impact assessment, budgeting, resource generation, rationalization of investment pattern (allocation and expenditure components), staff planning, career advancement, stakeholder management, service rules, administration, etc. should be put in place. International support for human resource development and infrastructure development is shrinking over time, and therefore, NARSs should allocate adequate resources for these critical activities.

SUMMING UP

This paper has examined the agro-ecoregion, commodity priorities in South and West Asia. This is followed by a discussion on major production constraints and growth opportunities, which are subsequently used for identification of priority research themes for each of the agro-ecoregions. The results indicate increasing importance of livestock and horticultural sector in the region, besides continuing emphasis on food crops – rice, wheat and pulses. Based on growth potential and likely impact of poverty, the humid ecoregion comprising eastern India and Bangladesh should get high priority. In terms of broad research themes, soil and water management, commercialization and diversification of production systems, market integration, livestock (including fisheries) health and nutrition, mapping of poverty, sustainable seed and technology systems are some of the high priority areas. These priority themes may also be of common interest to all stakeholders (IARCs, NARSs, private sector, donors, etc). The NARSs can use these results for resource allocations. Similarly, IARCs and donors can use broad research areas for directing their resources and developing linkages with the NARSs. These priority areas could also be used to assess adequacy of research investments, needs for human resource development, information communication initiatives, partnership and policy support. Of course, some refinement or modification of these research priorities may be required according to needs and goals of the research system.

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Annexure: Major production constraints and growth opportunities in various agro-ecoregions

Agro-ecoregion	Major production constraints			Opportunities
	Natural resources	Technical	Socio-economic	
South Asia				
Hot Arid Agro-ecoregion	Desert soil, soil erosion by wind, very low rainfall, frequent droughts, acute shortage of groundwater	Saline and alkaline soil in coastal area, shortage of fodder	High risk, resource poor farmers	Arid horticulture, livestock
Semi-Arid Agro-ecoregion	Deterioration of soil and groundwater resources, erratic rainfall, soil erosion due to water	Biotic stresses, moisture stress, low to poor soil fertility, low yields, limited use of crop products	High risk, resource poor farmers, threats from opening of markets, declining consumption of coarse cereals, high incidence of poverty, weakening of traditional institutions for management of natural resources	Diversification towards high value crops, scope for rainwater water harvesting and use
Sub-Humid to Cold Arid Mountain Agro-ecoregion	Diverse production environments, highly fragmented small holdings	High post-harvest losses, root stock susceptible to biotic and abiotic stresses	Resource poor farmers, poor infrastructure and institutional development, high incidence of poverty, labor migration	Rich biodiversity, value addition through processing, Horiculture and off-season vegetables, ecotourism
Irrigated Sub-Humid Agro-ecoregion	Deteriorating soil and water resources, salinity and water logging	Stagnant crop yields, late planting of crops, pest buildup, inefficiency in input/ resource use, nutrient depletion, poor plant stand, low productive efficiency in livestock	Shortage of labour, high population pressure, unstable prices of commercial crops, deceleration in total factor productivity	Favourable production environment, developed infrastructure and institutions
High Rainfall Humid Agro-ecoregion	Adverse soils, soil erosion by water, submergence, drought and flood prone, Diverse production environment, soil salinity, arsenic contaminated groundwater	High incidence of biotic stresses, low soil fertility, and nutrient deficiency high mentality in livestock	High risk, low input use, poor infrastructure and institutional development, high incidence of poverty, low non-farm employment opportunities	High rainfall, scope for diversification, *boro* rice, rich biodiversity, inland aquaculture
Sub-Humid to Humid Coastal Agro-ecoregion	Deterioration of land and water resources, soil salinity, frequent cyclones	Low soil fertility, diseases in inland fisheries, biotic stresses	High risk, competitive export market of plantation crops	Expansion of inland aquaculture
West Asia	Harsh production environment (drought, cold, heat and salinity), very low rainfall, acute shortage of groundwater, soil erosion	Poor soil fertility, shortage of fodder, biotic stress, over grazing of pastures	Inadequate input and technology delivery system, dependence on food imports	High value commodities

Source: Compiled from various published and other sources.

Towards Enhancing Agricultural Productivity and Sustainability in East and Southeast Asia Region

PATRICIO S. FAYLON*

INTRODUCTION

In 1997 and 1998, the Asian financial crisis reduced wealth and incomes, increased unemployment and inflation and heightened food insecurity in the worst affected countries of the region. By the first quarter of 1999, most of the economies of the affected countries were recovering, and this recovery process was consolidated during 2000. According to International Monetary Fund (IMF), real Gross Domestic Product (GDP) growth in developing Asian countries had increased to 5.9% in 1999, up from 4.1% in 1998. For both 2000 and 2001, IMF projected GDP growth rates of slightly above 6.5% (FAO, 2001).

In terms of agricultural growth performance in the Asia and the Pacific region, the average annual rate of production growth for 1996-2000 amounted to 3.2% compared with the average rate of 4.6% attained during the preceding 5-year period (FAO, 2001).

The Asian economic crisis posed a number of challenges to the agriculture sector. It was to absorb displaced labour, contribute to foreign exchange revenues, increase domestic food supply and generate resources for domestic investment.

The East and Southeast Asia sub-regions recovery from the worst recession in half a century is now well underway as economic reforms raise hopes for sustainable economic growth and new progress in the war on poverty. Millions of people in the sub-regions are striving to rebuild their standard of living after suffering from a sudden and serious decline when the so-called "miracle" years ended after several decades, in which the sub-regions' performance was the envy of the developing world. Despite signs of improvement, however, East and Southeast Asia's former crisis economies are experiencing an uneven and uncertain journey on the road to economic renewal (World Bank, 2000).

Global trends in use of resources are mainly attributed to rapid growth of populations and the corresponding rise in resource consumption and standards of living. The two sub-regions follow the same path. Depletion and unprecedented extraction of natural resources follow rapid economic growth characteristic of the sub-regions. Table 1 shows that about 2 billion people inhabit the sub-regions, with East Asia accounting for 75%. The sub-region's total land area is estimated at 16.27 million sq. km. With the exception of China, Cambodia, Lao PDR, Myanmar, Vietnam, and Thailand, a big chunk of the region's population resides in the urban areas.

There is a large variation in the incidence of poverty across the countries of East and Southeast Asia, ranging from a high of 34.5 per cent in Cambodia in 2000, to a virtual elimination of poverty at a-dollar-a-day in the case of South Korea and Malaysia. This variation in poverty incidence, together with the variation in size of countries, implies a large variation in the contribution to the total number of poor (World Bank, 2000).

* Executive Director, Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCCARD), Los Baños 4030 Laguna, Philippines.

While the process of agricultural modernization has enabled major gains in agricultural output as shown in Table 1 with an increase in value added from agriculture, it had very asymmetrical effects on rural societies and on the income and productivity levels of small-scale traditional farmers vis-à-vis those involved in industrial agriculture (FAO, 2000).

Table 1: Selected data profiles of East and Southeast Asian countries

Country	Population	% Urban population	Land area (sq. km.)	Agriculture, value added (% of GDP)	Poverty incidence (%, 2000)
East Asia					
China	1.300 b	31.60	9.6 m	17.60	14.7
Japan	0.1266 b	78.70	0.3778 m	1.90	–
North Korea	0.0234 b	60.00	0.1205 m	–	–
South Korea	0.0469 b	81.20	0.0993 m	5.00	13.3*
Mongolia	0.0024 b	63.00	1.600 m	31.30	
Sub-total	1.4993 b		11.7976 m		
Southeast Asia					
Brunei	0.3210 m	71.60	0.00577 m	2.50	–
Cambodia	11.8000 m	15.60	0.181 m	52.10	34.5
Indonesia	207.000 m	39.80	1.9 m	19.50	10.5
Lao PDR	5.1000 m	22.90	0.2368 m	55.70	31.5
Malaysia	22.7000 m	56.70	0.3298 m	10.70	neg.
Myanmar	45.0000 m	27.30	0.6766 m	59.90	–
Philippines	74.3000 m	57.70	0.3 m	17.70	12.0
Singapore	4.0000 m	100.00	0.00062 m	0.20	–
Thailand	60.2000 m	21.30	0.5131 m	10.50	3.7
Vietnam	77.5000 m	19.60	0.3317 m	25.40	12.2
Sub-total	0.5079 b		4,47549 m		
Grand Total	2.0072 b		16.27 m		

* Poverty line was set at $1.08 per person per day, except in South Korea, for which the national poverty line equivalent to about $7.94 per person per day was used.

Source: World Bank Report, 2000.

Agricultural intensification and diversification are the only available options for safeguarding food security as well as improving the security of livelihoods of the rural poor in the sub-regions. Conservation and sustainable utilization of biodiversity are essential for halting the deteriorating balance of food and people (Swaminathan, 1994).

AGRICULTURAL RESEARCH FOR DEVELOPMENT (ARD)

East and Southeast Asia made rapid progress in reducing poverty in the 1990s. However, the Asian economic crisis interrupted progress in some countries. Despite the slowdown in poverty reduction, the sub-regions lead the world in progress towards meeting the International Development Goals (IDG), embraced by 160 nations. In 1998, the sub-regions had achieved the IDG of reducing extreme poverty, defined as the proportion of the population living under $1/day, by half between 1990 and 2015. The proportion of population under this poverty line is estimated at 13.2 per cent in 2000 compared with 27.6 per cent in 1990. Yet, social vulnerability remains high: nearly half the population (48 per cent in 2000) lives on less than $2/day (World Bank, 2000).

Heightened focus on poverty alleviation paved the way for a systematic review of the impacts of past efforts, resources channeled, and the extent of complementation of activities among nations. According to FAO Report (2000), while the process of agricultural modernization has enabled major gains in agricultural output overall, it had very asymmetrical effects on rural societies and on the income and productivity levels of small-scale traditional farmers vis-à-vis those involved in industrial agriculture. Along this line, technological advancement, rendered possible by research and investment efforts and by support from national and international research centres, play irreplaceable roles.

The amount of investments in research and development (R&D) greatly contribute to the significant mileage the agricultural sector has accomplished over the years. In the Asia-Pacific Association of Agricultural Research Institutions (APAARI) Vision 2025, it is indicated that in recent years, private sector investment in agricultural research is increasing. Currently, the private sector accounts for 10-15 per cent of resources invested in developing countries compared to about 50 per cent in industrial countries. However, the private sector has to be more involved in these countries as a proactive partner. Studies conducted have found a high rate of return to investments in agricultural research in developing countries.

On the other hand, investments by national governments in Asia (excluding China) in public agricultural research in real terms more than tripled over the past two decades; from US$0.9 billion in 1971 to nearly US$3.5 billion in 1991. In other words, expenditure on publicly performed agricultural research grew by 7.3 per cent as against 3.6 per cent growth at the global level (APAARI, 2000).

No nation can win the war against poverty without improved food and agricultural production through technological advancement. And given the meagre investment being channeled by each country to agricultural research for development, collaboration built on positive experience of parallel system such as the National Agricultural Research Systems (NARS) of East and Southeast Asia become vital.

Research priority setting banks on this synergism, opening up opportunities for each NARS to jointly find solutions to address poverty and hunger through growth in agriculture.

East and Southeast Asian Regional Priority Setting as a Strategy for Multi-Stakeholder Collaboration

Regional priority setting is viewed as a means to unify programmes and activities that can effect wider application at a regional arena. It was proposed for the following reasons: (i) many countries do not have the necessary resources to reach the critical mass of researcher and to address relevant issues, therefore the need to help each other; (ii) it is seen as an opportunity to better customize technology to the specificity and heterogeneity of poverty in particular countries; (iii) identify what each stakeholder can do by coming up with opportunity of complementarity among stakeholders in order to develop a critical mass of researchers and achieve greater impact.

As a unified system and under the guidance of APAARI, the different NARS in the East and Southeast sub-regions met in IRRI, Philippines on 27-28 June 2001 to enhance priority-setting capabilities and to re-visit the priorities identified in 1996. The end in view was to build on the strengths and milestones of some NARS while enhancing the capabilities of the weaker ones. The exercise was also aimed to focus resources, both human complement and financial, to priority and more pressing concerns of regional proportion. A number of added benefits to the sub-regional priority setting exercise are as follows:

1. better understanding of regional development needs towards focused and problem-oriented programmes in agricultural productivity and resource conservation;

2. consensus-building and joint ownership of ideas and technological breakthroughs based on the convergence of needs and aspirations in the sub-region;
3. more participatory development and enhanced synergism, based on the inputs of all stakeholders and as defined within the context of a regional priority framework, and
4. complementarity in upgrading R&D capabilities to develop a critical mass of researchers that will churn our significant advances in technological base of any one NARS.

The Approach to Priority Setting

Sometime in March 2001, the APAARI initiated a move to come up with a Research Priority in the Asia-Pacific Region. Three sub-regional exercises to define agriculture and natural resources R&D priorities were facilitated, namely: West and South Asia, East and Southeast Asia and the Pacific Island.

The East and Southeast Asia Priority Setting Exercise was coordinated by PCARRD with International Rice Research Institute (IRRI) and Southeast Asia Regional Graduate Study in Agriculture (SEARCA) as partner institutions. The idea was that since IRRI was tasked by the CGIAR to coordinate a priority setting exercise for the CG centres in the sub-region, it was very timely that APAARI dovetail its priority setting exercise to draw more stakeholders in the process. In the same manner, SEARCA was also planning to have a priority setting exercise in the sub-region, hence their involvement proved to be more efficient.

The three-day exercise included four plenary sessions namely: (i) presentation of priorities of donors, regional organizations, NGO and the NARS; (ii) presentation of selected cases of multi-institutional collaboration; (iii) presentation of synthesized output by sectoral classification of the activities of CG centres, and (iv) presentation of the framework for the process of setting regional research priorities and collaboration. These presentations were organized to set the tone for the workshop.

Prior to the activity PCARRD had requested each of the NARS to assess their research activities and submit their respective priorities. PCARRD synthesized the submitted information and came up with the draft priorities, which were presented during the consultation. The priorities synthesized were then validated during the workshop.

The same is true for the CG centres, prior to the priority setting exercise IRRI already synthesized information from the CG centres and was presented during the consultation. Further, the CG centres representatives validated the output to include the priorities also of other stakeholders like donor agencies, NGO and regional organizations.

After each workshop groups have come up with the priorities (Output I and Output II as Appendix), these were further synthesized to come up with only one set of priorities for the East and Southeast Asia region. The framework followed is shown in Figure 1.

The Research Priorities

Table 2 presents the list of priorities in areas of research opportunities. These are the commodities and areas of convergence between the NARS, CGIAR and other stakeholders. It was noted that upon clustering of research areas, it resulted to four major clusters:

1. food security (agriculture, forestry, fisheries).
2. natural resources management.
3. increasing farmers' income.
4. supporting R&D (cross-cutting concerns).

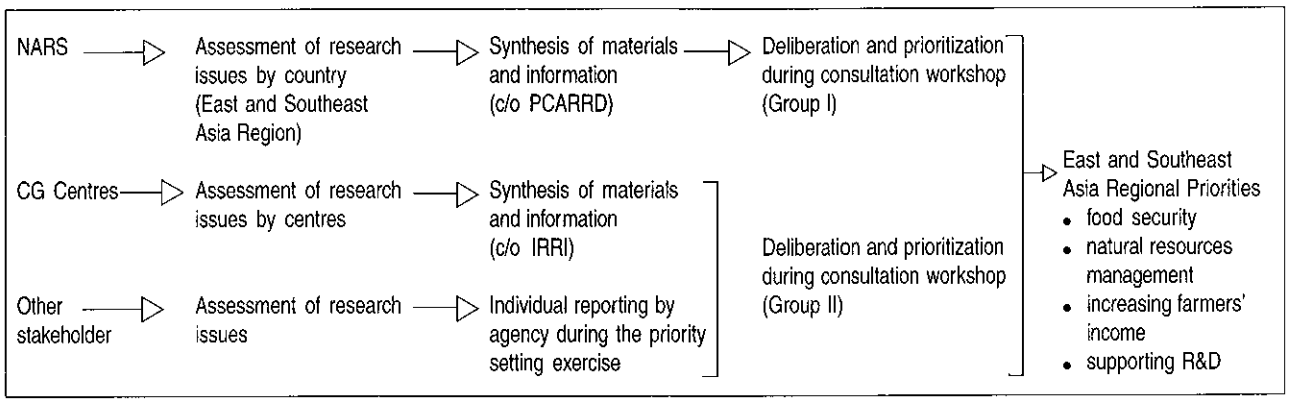

***Fig. 1:** The approach to priority setting framework*

Table 2: Areas of research opportunity

Sector/Theme	Researchable Areas
Agriculture/forestry (food security)	• integrated pest management • increase production • increase quality/competitiveness • increase biosafety • biotechnology/cutting edge technology for new industry
Natural resources management	• biodiversity conservation • environmental conservation • shifting cultivation/agriculture • soil and water management • sustainable agriculture development
Fisheries	*Coastal resource management* • coastal/offshore fisheries assessment • marine protected areas • pollution/environmental degradation • resources/habitat enhancement/rehabilitation • maintenance of biodiversity • stock delineation/management • cost effective monitoring and surveillance system • reduction of postharvest losses • improvement of fish processing technology *Aquaculture* • genetic improvement • fish health management • environmental friendly aquaculture *Policy* • Economic and social analysis of aquatic resources in developing countries • Aquatic resources planning and impact assessment • Legal and institutional analysis of fisheries management
Common areas/cross cutting concerns	• information technology (including access) • capacity building • policy research • marketing • enterprise development • technology transfer/dissemination and farmer improvement • private sector involvement

Under each major cluster are specific areas of concerns. It could be deduced from the list that increasing production and using biotechnology as a tool were given high priority. This shows that the primary objective of all stakeholders in the East and Southeast Asia Region is feeding the ever-expanding population, satisfying the growing demand for safe and high quality food and at the same time protecting and conserving the natural resource base.

Because of the uniqueness of each of the sub-regions, a diversity of approaches to priority setting was used by the different sub-regions. APAARI, in an effort to rationalize and standardize the R&D priorities initiated the agro-ecological approach. Specifically, the reason behind this approach are: (i) to put greater emphasis on improving the management of natural resources for specific ecosystems and (ii) this approach will provide a thematic context in which the alternative methodologies identified can be developed and for which multi-stakeholder participation can be made possible.

For the East and Southeast Asia Regions, five agro-ecological regions were identified as follows:

Freshwater Ecology[1]

- Occupy a relatively small portion of the earth's surface as compared to marine, but their importance to man is far greater than their area for the following reason:
  - most convenient and cheapest source of water for domestic and industrial needs
  - most convenient and cheapest waste disposal systems

Marine Ecology[2]

- The features of the sea which are of major ecological interest may be listed as follows:
  - covers 70% of the earth's surface
  - the sea is deep and life extends to all its depths
  - the sea is continuous, not separated as in land and freshwater habitats; all oceans are connected
  - the sea is in continuous circulation
  - sea is dominated by waves and tides which are important in the shoreward zones where marine life is often especially varied and dense

Irrigated Agro-ecoregion[2]

It has exhausted all past sources of growth in agriculture, levels of diversity (system and production) are low; profit margins are under pressure because of overintensification of production process; ground water is depleting rapidly and salt affected areas are substantial, threatening sustainability of the system.

Mountain and Hill Agro-ecoregion[3]

Widespread and diversified; production environment varies with difference in altitude, slope, climate and rainfall; productivity is constrained by poor infrastructure (including markets, rural institutions, electrifications, etc.); low technology penetration, land degradation and unsustainable practices.

Rainfed Agro-ecoregion[3]

Morethan 90% of the value of crops comes from rainfed land use.

The research areas for these agro-ecological-region are given in Table 3.

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[1] Odum, Eugene P. 1971 Fundamentals of Ecology. W.B. Saunders Co., USA

[2] Classification issued by the Sub-Regional Agricultural Research Priorities for South and West Asia Region

[3] ILRI Impact Assessment Series No. 6. Assessment of priorities to 2010 for the poor and the environment, 2000.

CONCLUSION

In many parts of East and Southeast Asia, populations continue to rise, coupled with growing rates of resource extraction, uneven distribution of resources, and inability to access available food. Providing food security and addressing widespread poverty are now mainly a demographic issue. For the most part, agricultural and natural resources research and development is a crucial requirement to attend to the needs of the gradually expanding number of people as well as the increasing levels of standards of living.

The multi-faceted and interconnected nature of the regional issues – food security, loss of biodiversity, widespread poverty, unsustainable extraction of resources, and the like – necessitates consolidation of efforts at the regional and sub-regional level of agricultural systems. Experiences in the past point to the inefficiencies and ineffectiveness of independent and fragmented national systems working on the challenges of agricultural productivity and sustainability. Many NARS are

Table 3: Research priority areas of agro-ecological regions

Agro-ecology	Researchable Areas
Freshwater Ecology	• coastal/offshore fisheries assessment • pollution/environmental degradation • resources/habitat enhancement/rehabilitation • maintenance of biodiversity • cost effective monitoring and surveillance system • stock delineation/management • reduction of postharvest losses • improvement of fish processing technology
Marine Ecology	• marine protected areas • genetic improvement • fish health management • environmental friendly aquaculture • economic and social analysis of aquatic resources • aquatic resources planning and impact assessment • legal and institutional analysis of fisheries management
Irrigated agro-ecoregion	• integrated pest management • increase production • increase quality/competitiveness • increase biosafety • biotechnology/cutting edge technology for new industry • marketing (processing and distribution system) • enterprise development
Mountain and hill agro-ecoregion	• biodiversity conservation • environmental conservation • shifting cultivation/agriculture • management of soil/water • Rainfed agro-ecoregion sustainable agriculture development
Cross cutting concerns	• information technology • capacity building • policy research • marketing • enterprise development • technology transfer/dissemination and farmer empowerment • private sector involvement

short of funds and resources to address its internal problems; yet, the same problems have already been attended to by the more advanced NARS. In the same breadth, vast opportunities are open to NARS within the context of regional partnerships and collaboration.

With the list of priorities at hand, the next steps would be:

1. Future research activities should be aligned to these priorities.
2. This exercise should be manifested as the concerted efforts among all stakeholders and thus, implementation of these priorities should be taken as pact of all stakeholders to better harmonize R&D activities in the region and channel resources to the most pressing need.
3. APAARI, as a regional forum can facilitate the initiation of the activities by providing the environment for multi-stakeholder involvement to address those priorities.

With these, the weaknesses can be harnessed to become strengths and the strengths can be fully harnessed to address common priority areas in the realm of agricultural productivity and resources sustainability. This move to systematize priority setting on the East and Southeast Asia Region is a noteworthy development to maximize the vast potentials of formidable resources and team of experts dealing with regional and global challenges.

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APPENDIX

Group I Output: Priorities identified

Agro-ecological regions/research Priority areas	PROC	KOR	JAPAN	THAI	PHIL	VIET	CAM	MAL	MYAN	NDO	LAO
Irrigated agro-region											
– integrated pest management	H	L		H	H		H		H	L	L
– increase production	H	L		H	H	L	H		H	H	H
– increase quality/competitiveness	H	H		H	H	H	H	H	H	H	L
– increase biosafety	H	L		H	H	H	L	H	L	L	L
– biotech/cutting edge technology for new industry	L	H	H	H	H	L	L	H		H	
– marketing (processing and distribution system)	H		H	H	H	H	H	L	L	H	H
– enterprise development	H			H	H		L	L	L	L	H
Mountain and hill agroecoregion											
– biodiversity conservation	L	H		H	H	H	H	L	H	H	H
– environmental degradation (conservation)	L	L	H	L	H			H	L	H	
– shifting cultivation/agriculture	H			L	L	L			H	L	H
– management (soil, water)	L	H		L							
		L	L	H		H	L				
Rainfed agro-ecoregion											
– sustainable agriculture development			H	H	H					L	
Cross-cutting concerns											
– capacity building	L			H	H	L	H	L	H	H	H
– information technology				H	H	H	H		L	L	L
– policy	L	H	H	H	H	L	L	H	L	H	

Group II Output: Priorities identified

ADB	FAO	ANGOC	ASEAN	CGIAR	AVRDC	GFAR	SEARCA
1. Sustainable & remunerative farming system	Contributing to the eradication of food insecurity & rural poverty	200 village project with Asian rural communities	Technology generation & transfer to increase productivity & develop agribusiness	–	Poverty reduction	–	Sustainable farming system
2. Enhancing income and living standards of women	–	–	–	–	–	–	–
3. Sustainable management of ANR	Suggesting the conservation, improvement and sustainable use of natural resources for food and agriculture	Sustainable agriculture & resource development	Management sustainable utilization and conservation of natural resources	Germplasm and natural resource management	NRM and sustainable agriculture	–	–
4. Enhancing productivity of agriculture	Creating sustainable increase in the supply and availability of food and other products from crop, livestock, fisheries & private sectors	–	Strengthening food security arrangement in the ASEAN Region	–	Food security (crop improvement, improvement of production systems)	–	–
5. Enhancing the capability of NRS	–	–	Enhancement of private sector involvement Agricultural rural community & HRD	Capability building	–	Promoting innovative partnership Access to information	Capability building in agriculture research Access to information
6. Public policy & socio-economic research	Promoting, developing & reinforcing policy & regulatory frameworks for food, agriculture, fisheries & forestry Improving decision making through the provision of information & assessment & fostering of knowledge management for food & agriculture	Agrarian reform and resource rights Participatory local governance	Facilitation and promotion of intra-extra ASEAN trade in agriculture, fishery & forest products Strengthening ASEAN cooperation joint approaches in addressing international and regional issues	Policy research technology dissemination	–	–	–

Research Priorities for the Agriculture, Forestry and Fisheries Sectors in the Sub-Pacific Region: A Synthesis

R.D. GHODAKE*

INTRODUCTION

Research is an important integral part of the planning and development in the agriculture, forestry and fisheries sectors in the Pacific Island Countries and Territories (PICTs). Many research activities in the past have been conducted in the Pacific, and their findings have influenced decision making in policy and development. If properly prioritised, designed and executed, research has high potential in contributing to and realisation of sustainable development, socio-economic growth and welfare of people in the Pacific region. It can also greatly enhance individual country's ability and capacity to provide guidance for policy and future development in respective sectors.

In order to be efficient and effective, research should provide solutions to priority constraints and problems, and must explore new opportunities, which lead to development and contribute to welfare of people. Therefore, research issues and areas need to be prioritised, based on the development needs and aspirations of nations and stakeholders (rural community, in general).

PRIORITY SETTING EXERCISE IN THE PACIFIC SUB-REGION: A FRAMEWORK

A framework was developed by modifying the priority setting methodology used by CSIRO in Australia, and by using the experiences gained in developing research priorities in Papua New Guinea (Ghodake *et al.*, 2001). The framework outlined the approach and process, and methodology for assessing, synthesizing and developing priorities and strategic directions for research in the sub-sectors of agriculture (crops and livestock), forestry and fisheries for the Pacific sub-region.

Purpose and Objective

The purpose of the priority setting exercise was to develop research priorities, and determine strategic directions in the sub-sectors of agriculture (crops and livestock), forestry and fisheries for the Pacific sub-region. Such sub-regional priorities were to be considered and incorporated into an equivalent set of strategic directions and research priorities for the Asia-Pacific region at the forthcoming APAARI regional meeting in November 2001. This analysis would provide input into ongoing development of research programmes of the International Agricultural Research Centres (IARCs), the National Agricultural Research Systems (NARS), and regional initiatives by regional and international organisations, and would form a basis for consideration by donors of resource requirements.

The overall objective of the priority setting exercise for the Pacific sub-region was to identify and assess research problems and research issues within specified areas of research opportunities, which would then be prioritised within each of the sub-sectors. The basic premise is that appropriate

* Deputy Director General, National Agricultural Research Institute (NARI), Lae, Papua New Guinea.

research, if it addresses these problems/issues successfully, will most effectively contribute to the improvement of the productivity and sustainability of the existing (given) production systems, development of new options and opportunities, and improvement of the quality and quantity of natural resources base. Ultimately, this should contribute to the overall economic and social well being of communities in the countries and the Pacific sub-region.

Expected Outputs

The key expected outputs of the priority setting exercise were to provide:

i) research priorities and strategic research directions for the Pacific-sub-region as a basis for developing research priorities for the Asia-Pacific region;

ii) a basis for developing networks, partnership and funding arrangements between and among (NARS), sub-regional and regional organizations, and the IARCs;

iii) strategic national research directions and priorities for the participating and representative countries in the Pacific sub-region; and

iv) systematic approach, process and methodology for deciding research focus and allocation of research resources within individual countries and within the Pacific sub-region.

Steps in Priority Setting

The priority setting exercise in the Pacific sub-region involved the following three major steps:

a) assessment of research problems and research issues by selected representative participating countries of the Pacific sub-region;

b) synthesis of material and information from existing strategies, programmes and documents available from various fora and meetings relevant to the sub-region; and

c) deliberations and outcomes of a consultation workshop held in October 2001.

ASSESSMENT OF RESEARCH AREAS AND RESEARCH ISSUES

Assessment Criteria

Having identified research problems/issues, the next step is to undertake an assessment of these areas and issues within each area of research opportunity.

The basis may be to realize the objective of maximizing returns (from research investment) to the nation in terms of increased production, productivity, income, employment, assured food and nutrition security, improved quality and quantity of natural resources, and all, collectively and/or individually, leading to sustainable development and socio-economic growth.

To reflect this objective in the assessment process, the research areas and issues can be assessed by using the following portfolio criteria, which are mutually exclusive and independent. These are 1) potential benefit, 2) adoption likelihood, 3) scientific potential, and 4) research capacity. The assessment can be quantitative and/or qualitative.

Potential Benefits

The potential benefits can be in terms of extent of economic and social impact, extent of environmental impact and enhancement of research capacity. This will refer to research problems/issues to be addressed, size and scope of the problem/or opportunity to be addressed, and nature of benefits arising;

- increased production/expanded production.
- increased productivity of resources/inputs.

- reduced cost per unit of output.
- increased cash income.
- increased employment and utilization of resources/inputs.
- improved sustainability/reduced degradation of resources.
- assured food security/improved nutrition/reduced risk.

Potential benefits increase with larger size of the area, faster growth, greater reduction in costs, higher research intensity, greater and positive environmental and social impact, and greater spillover benefits.

Adoption Likelihood

This will cover probable users of likely research outputs and services, past performances in adopting similar results, and major impediments and inducements to uptake outputs. Specific points to be covered are appropriateness of technology, uptake events and directness of impact, capacity to use/adapt and deliver, capacity of extension and other service providers, and impediments/incentives to uptake. Some of the strengths and opportunities assessed earlier may be inducement for adoption, while some of the weaknesses and threats may be impediments to adoption.

Adoption likelihood improves with the faster adoption rate, more favourable government policies and regulations, higher research intensity and level of innovation, and higher international competitiveness in trade.

Scientific Potential

This can consider the availability of tools and techniques/scientific advances, existence and availability of relevant disciplines/networks not only in the country but also in the Pacific sub-region and globally, and probability of success in achieving research results (research risk), and time to produce research outputs.

Scientific potential becomes higher with faster rate of change in relevant disciplines, greater likelihood of scientific advance, better research tools and techniques, and higher ratio of basic and strategic research to applied research.

Research Capacity

This accounts for and reflects the research/technical skills/quality and breadth of skills, critical mass of efforts, financial support, and quality of research infrastructure and support. It should take into account capacity and ability of organizations, networks and collaborative arrangements that are/or may be involved in the country or, to an extent, in the sub-region, and the capacity to access global knowledge.

Research capacity improves with the quality and breadth of skills available, ability to put together high performing research teams, efficiency of running research, quality of infrastructure, equipment and information systems, and quality and efficiency of support staff.

Priorities Framework

Figure 1 shows the framework for assessing priorities.

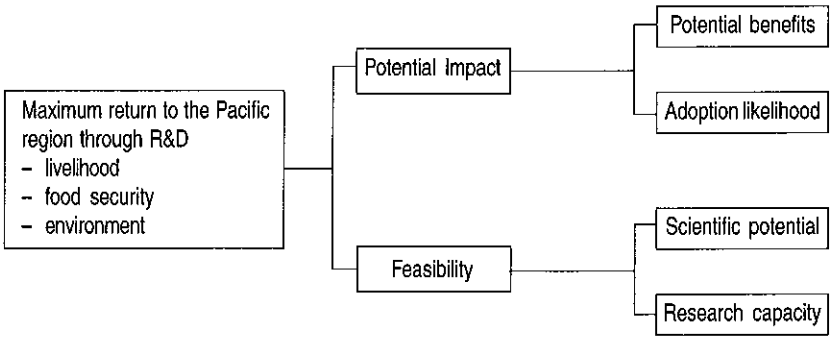


Fig. 1: Framework for assessing priorities

Selectivity in Research Emphasis

Figure 2 shows the priority setting, as assessed on the basis of two main criteria, i.e. impact potential and feasibility; and their approximate relationship to the level of selectivity and emphasis.

Highest priority is assigned to high impact and high feasibility research areas, and that appears in the right hand side top corner of the figure; lowest priority is assigned to low impact and low feasibility research area and that appears in the left hand side bottom corner of the diagram. Strong emphasis is then placed on the highest priority areas while more limited support is considered for the lowest priority areas. As one moves from highest to the lowest priority areas, increased selectivity is exercised in deciding on research projects and programmes within these lower priority areas; lower priority does not imply lesser importance.

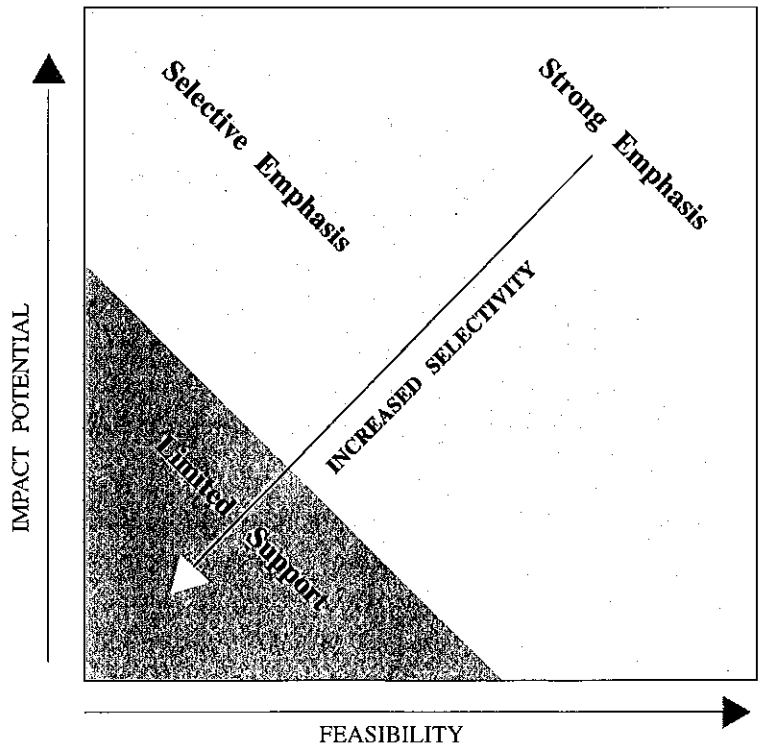


Fig. 2

RESEARCH PRIORITIES AND STRATEGIC DIRECTIONS IN THE PACIFIC REGION

Understanding the Region

A brief overview of the sub-regional priorities, can be outlined as:

1) the main development issues for the agricultural, fisheries and forestry sectors.
2) national aspirations for these sectors.
3) most important drivers influencing the achievement of these national aspirations – a) external to the country and b) internal to the country.

Most Important Features in the Region

The most important features of the agricultural, fisheries and forestry sectors in the region include:

1. The countries have very diverse environments, resources, production systems, capabilities and cultures coupled with changing lifestyles.
2. There have been changing national policies in recent times, without consistent and consequent policies for these three sub-sectors.
3. In general, most countries lack systematic planning and prioritisation in these sub-sectors.
4. There are limited skilled human resources, inadequate infrastructures and lack of relevant information and access to wider information systems.
5. The countries are concerned about sustainability of environment and resources, and these sectors are highly vulnerable to the weather and environmental factors.
6. The countries have poor access to export markets and face declining prices for export commodities.
7. There is a multiple and complex ownership of resources and land tenure arrangements, with dominance of small traditional subsistence and semi-subsistence farmers and fishermen.
8. The region is resource rich but income poor, with income disparities among and within countries and their peoples.
9. The region is heavily influenced by external donors and organizations, and resource rent seekers, particularly in forestry and fisheries.

Aspirations of the Region

The aspirations of the region are:

1. Alleviation of poverty among the rural population.
2. Improved food security, food safety and quality, incomes and employment.
3. Sustainable development of sub-sectors and of rural based industries.
4. Prevention of the urban drift by improving the standard of living in the rural areas, resulting from maximizing current income and not future income.
5. Improved information access and literacy.
6. Improved market access, processing, value adding and quality.
7. Increased need and desire to export and participate in the international markets.
8. Capturing indigenous knowledge for food security and to maintain viability of local communities.
9. Improved capacity in research, development and extension.
10. Integration of indigenous crops and knowledge in research practices.
11. Regional collaboration and research coupled with local ownership and participation.
12. Development and implementation of regional collaboration and co-operation in research and development.
13. Control and management of plant and animal diseases.

Most Important Drivers for the Sectors in the Region

The most important drivers for these sectors in the region are:

1. Increased poverty exacerbated by rising population growth, low rates of economic growth and reduction in the standard of living.
2. Socio-cultural obligations inhibiting individual enterprises.
3. Land tenure and resistance to reforms.
4. Poor public health services particularly in rural areas.
5. Low local capacity of human resources in accessing information.
6. Participation by in-country stakeholders.
7. Highly fluctuating and uncertain international commodity prices.
8. Funding from Government and level of Government investment in rural development.
9. Government policies and implementation of legislation and regulations.
10. Political instability.
11. Regional research and development organisations.
12. Influence of external aid donors and their leverage through funding conditionality.
13. International treaties and conventions.
14. Impact and influences of WTO and globalization.
15. Sustainability of the environment.

Regional Research Issues

The issues were synthesised within six groups of research areas (four commodity areas and two common areas) by using country papers, already available material in the region, prepared by SPC, AusAID, FAO, and others as primary information sources. The considered issues included those important for most countries, those important for several countries, major issues of importance to one country. The six groups were:

1. Crops
2. Livestock
3. Forestry
4. Fisheries
5. Natural Resource Management
6. Cross-cutting issues, especially in the areas of information, economics, and policy

The issues were then distilled within each of the six categories into broad research topics within research areas that were amenable for priority setting, i.e. mutually exclusive, collectively exhaustive, consistently grouped, forward looking, manageable in number (Tables 1 to 6).

Research into treaty incompatibility and ability of countries to fulfilling obligations and the development and implementation of standards for domestic trade.

Table 1: Major research issues and broad research topics – crops

Sr No.	Research Issues	Broad Research Topics
1	Value adding	Post-harvest operations, processing, storage, packaging, transportation, grading and quality improvement
2	Markets and marketing	Size of demand, quantity and quality, responses, processes, efficiency, market studies
3	Sustainable agriculture	Resources degradation, soil and land management, productive capacity of environment, use of pesticides and fertilisers, nutrient management
4	Plant genetic resources	Conservation, management, utilization, improvement, improved nutritional value, breeding, increased yield, off-season production, protection of sovereign rights
5	Drought and salinity tolerance	Soil, water and crop management, variety tolerance to environmental stress, atolls
6	Pest and diseases	Resistance/tolerance of material, IPM, ICM, biological control, plant derived pesticides
7	Accessibility and Utilization	Off-season and prolonged production and seasonality
8	Integration with livestock	Crops, livestock, and aquaculture integration

Table 2: Major research issues and broad research topics – livestock

Sr No.	Research Issues	Broad Research Topics
1	Human resources	Skilled human resources for management and development, technical skills, consumption attitudes
2	Feed formulation	Nutrition, feed formulation, locally available ingredients / resources
3	Pests and diseases	Health – diseases and pests
4	Management and husbandry	Management, husbandry, quality of outputs, preservation, productivity and efficiency
5	Animal waste management	Chemical residue, integration of animal waste in crop production
6	Zoonoses – animal/human diseases	Human diseases caused by animal handling, exposure to animals, novel diagnostic tests
7	Integration into sustainable agriculture	Integration with crops/farming systems, manure, draft
8	Livestock improvement	Genetic material/introduction, improvement, selection (but no breeding)

Table 3: Major research issues and broad research topics – forestry

Sr. No.	Research Issues	Broad Research Topics
1	Reforestation/Aforestation	Use of native species, sustainability of production and harvesting systems
2	Timber utilization	Improvement and use of Lesser Known Species (LKS), timber properties, preservation (improving durability), seasoning, processing and use of coconut timber, value adding processing
3	Forest health	Quarantine, invasive species, pest and disease management
4	Non-timber forest products	Management, husbandry, properties, quality of outputs, and preservation (improving durability)
5	Agro-forestry	Sustainability of atolls through agro-forestry and other land management practices; integration of agriculture with silviculture.
6	Integrated land use	Integration of forestry with livestock, cropping, fisheries
7	Forest product marketing	Production and marketing systems
8	Felling/cutting cycle	Inventory, growth, yield and policy issues, clearing for farming, sustainable management, silvicultural systems

Table 4: Major research issues and broad research topics – isheries (aquaculture and coastal fisheries)

Sr No.	Research Issues	Broad Research Topics
1	Aquatic bio-security	Assessment of risk and coping ability, diseases, quality and environmental friendliness, introduced species, impact assessment
2	Reef fishery status assessment	Status of reef fisheries, inventory and stock assessment, assessment of high value species, outreach and communications of results
3	Sustainable catch rates	Sustainability and wild catch resources management
4	"Turnkey" aquaculture systems	Narrowing down systems/farming systems to a limited range for national promotion
5	Standards assurance	Certification, quality assurance, sustainable export standards
6	Integration of reef management with government systems	Networking and shared management methods, harmonised legislation, resources owner reef management and government management system, policy development, foreign vessels monitoring systems
7	Aquaculture feeds and feeding	Feed especially proteins, fish pen culture, local alternatives, feed distribution, waste and disease management, poly-culture

Table 5: Major research issues and broad research topics – natural resource management

Sr No.	Research Issues	Broad Research Topics
1	Integrated natural resource management	Integrated systems involving agriculture, forestry, fisheries and maintenance of natural ecosystems
2	Farming systems	Sustainable agriculture interaction between bio-physical, economic and socio-cultural factors/ environments
3	Soil fertility	Soil and land management, fertility management/maintenance
4	Water management	Soil water conservation, irrigation, atolls
5	Environmental degradation	Management of nutrients, soil physical degradation, soil and water pollution, restoration of depleted nutrients, increased biodiversity
6	Waste management	Management and assessment of farm and municipal waste, composting of municipal and farm waste, composting
		Bioremediation

Table 6: Major cross cutting research issues and broad research topics

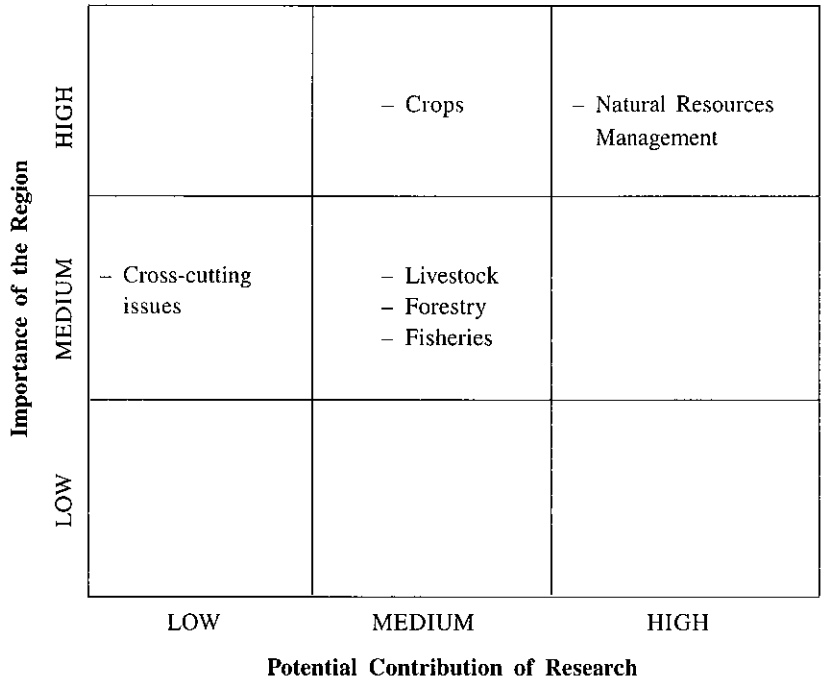
Sr No.	Research Issues	Broad Research Topics
1	Information packaging, access and use	Assessment and development of access, use and dissemination of information–effective management and dissemination
2	Supply and demand analysis	Supply and demand, analysis and estimation, markets and marketing systems research (industry analysis)
3	Production and marketing economics	Cost-benefit analysis, and cost-price analysis (at farm level)
4	Import and export policy	Policy and economic research into export, import and credit
5	Natural resource management policy	Research into policies on management of natural resources, environment, climate change, land and soil
6	Biodiversity policy	Research into biodiversity policies and management strategies
7	Risk management	Research into strategies of risk (macro-overall) management at national, regional and local levels
8	Treaty incompatibility	Research into treaty incompatibility and ability of countries to fulfilling obligations and the development and implementation of standards for domestic trade

Regional Research Priorities

Priorities Among Areas

The six research areas were first assessed with respect to 1) their importance to the region and 2) the potential contribution from research in resolving the major issues raised in these respective areas. Working groups reached agreement and rated the areas on the two criteria using a high, medium and low rating scale. Natural resources management and crops were rated as being the most important to the sub-region. The potential contribution was assessed to be the highest for NRM (natural resource management) and was the lowest for the cross-cutting issues. The other three areas–livestock, forestry and fisheries were assessed to be at the medium level. The ratings are shown below.

Regional Importance of Sub-Sectors



Priorities Among Research Issues within Research Areas

The issues within each of the six areas were discussed and rated against two criteria: 1) potential impact from successful research, and 2) feasibility of carrying out the work successfully.

The potential impact criteria took account of both the potential benefits that could arise and the likelihood that research products and services would be disseminated and adopted. The feasibility criteria considered the scientific potential and research capacity, although the latter was the main determinant of the feasibility ratings. The High-Medium-Low rating procedure was used again. The results are provided below.

PRIORITISATION RESULTS

Sector Implementation Strategies

Small working groups briefly considered principle focus and objectives and looked at some implementation strategies in each of the areas. A brief interpretation of the priority assessment and a summary of the principle objectives for each sector follows.

Crops

Potential Impact	LOW	MEDIUM	HIGH
HIGH		– Plant genetic resources – Pests and diseases	– Value adding – Markets/marketing
MEDIUM	– Drought & salinity tolerance – Accessibility & utilization	– Integration with livestock systems	
LOW			

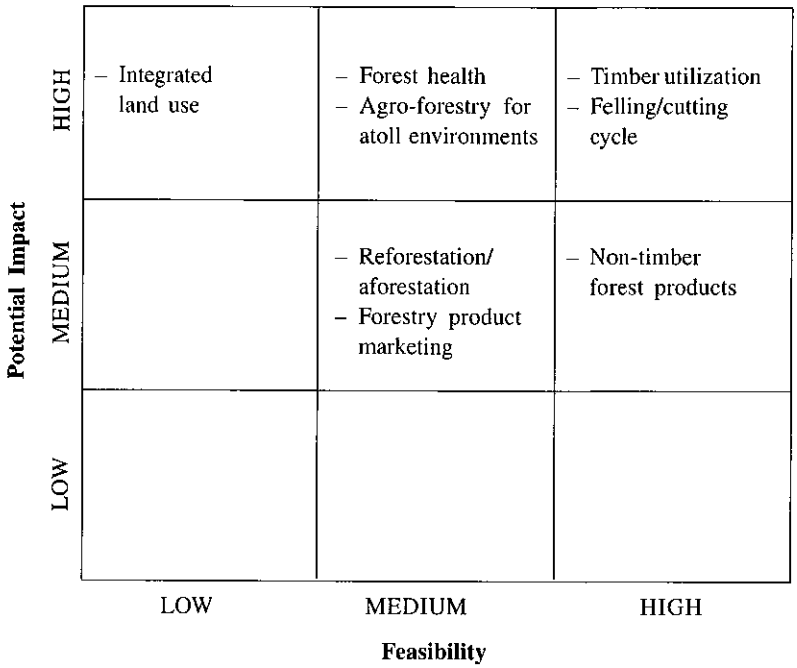
Feasibility

Livestock

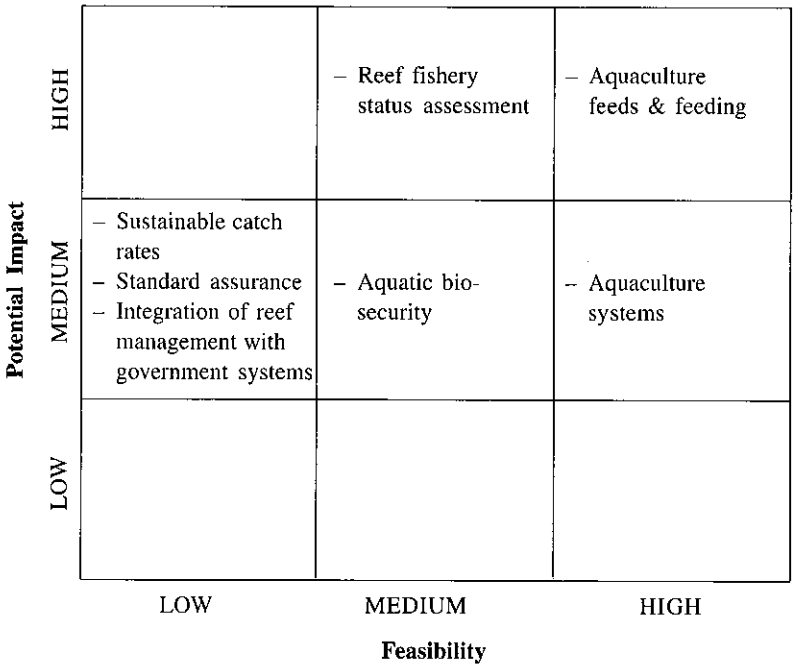
Potential Impact	LOW	MEDIUM	HIGH
HIGH	– Zoonoses	– Livestock improvement	– Feed formulation – Animal waste management
MEDIUM		– Human resources – Management & husbandry – Integration into sustainable agriculture	– Health – pests & diseases
LOW			

Feasibility

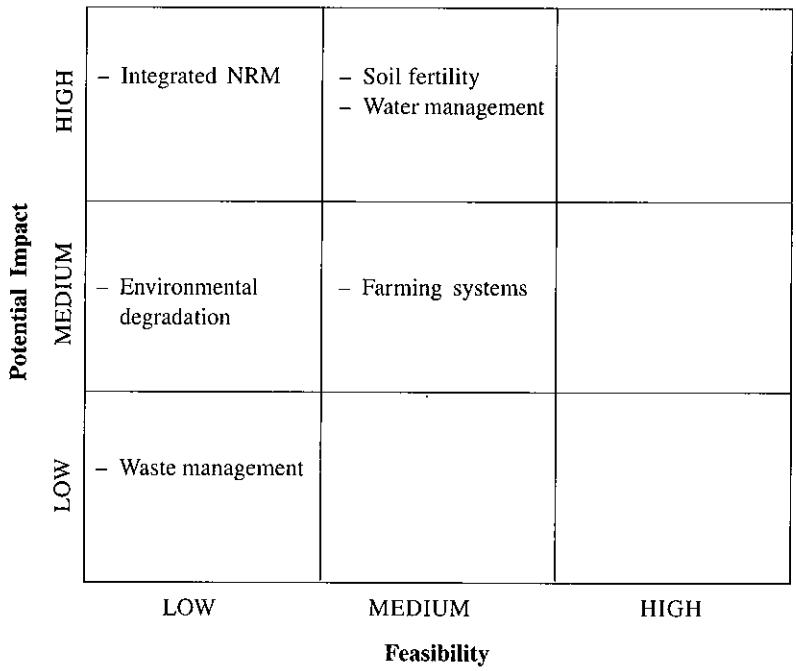
Forestry



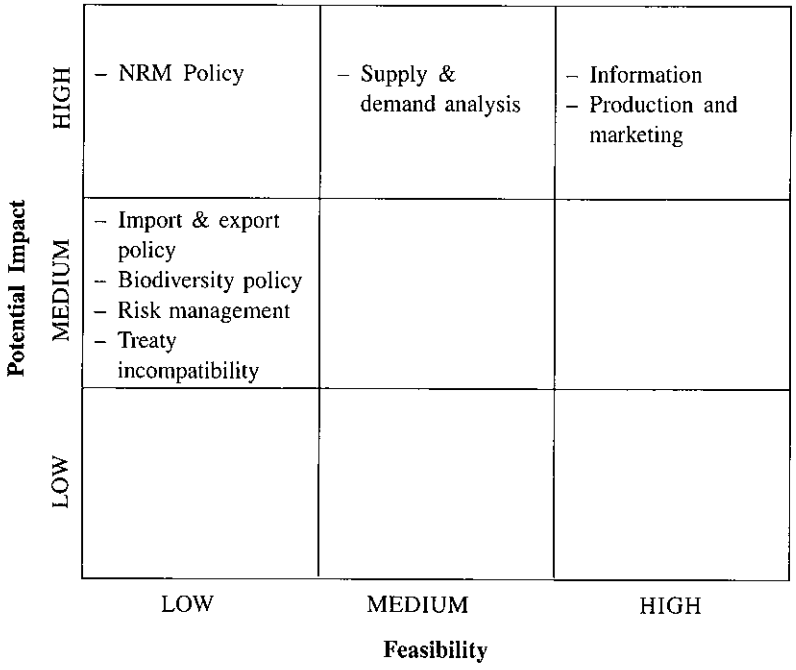
Fisheries



Natural Resources Management



Cross-cutting Issues



Crops

The priority assessment indicates that value adding and markets/marketing are the two issues warranting strongest emphasis in research. The high potential impact but moderate feasibility of plant genetic resources and pests and diseases suggest that ways of increasing research capacity in these areas should be examined. Selective emphasis should be accorded to drought and salinity tolerance and accessibility and utilization because of their low feasibility, arising by low likelihood of adoption. Integrated crop and livestock fared moderately and need objective consideration.

The principle objectives for work in the crops sector are the development of higher nutritional value crops to provide more balanced diet/nutrition and the production of high quality and valued (value added) produce/by-produce. Other objectives include increased yields and productivity per unit of time and resources; off-season or prolonged crop production for vegetables, fruits, breadfruit; plant varieties resistance/toleran to various environmental stresses, especially rice and breadfruit; biological control and management of pests and diseases and minimal use of chemical; a better understanding of the status of pests and diseases in the Pacific; and rat control, especially in Tuvalu, Tokelau and Kiribati (particularly atolls), and an objective consideration of crop-livestock integrated systems, especially in PNG.

Livestock

The assessment suggests that feed formulation and animal waste management received the strongest emphasis. The feasibility of making progress in the control of livestock diseases was assessed as being relatively high though only with moderate potential impact. The assessment of high potential impact from livestock improvement needs to be quantified, as there are unlikely to be significant gains from research into genetic improvement in the Pacific. The high potential impact of zoonoses was recognised although the feasibility was assessed as low. Human resources, husbandry practices and integrated systems fared only moderately on both impact and feasibility criteria.

The principle objectives for livestock research are to improve nutrition (animal and human) and productivity using locally available feed ingredients and reduce the impact of animal wastes on the environment and integrate animal wastes into crop production systems. Other objectives include establishing the disease status in the PICTs; identifying the role of livestock in integrated farming systems and developing management and husbandry models suitable to various PICTs; quantifying the prevalence and distribution of zoonoses; and building capacity for livestock research, ensuring that results are published and disseminated.

Forestry

Timber utilization and management, felling and cutting cycles are the issues requiring the strongest research emphasis, having high potential impact and feasibility. Forest health, agro-forestry for atoll environments and integrated land use were all assessed to have high potential impact but with concerns for the feasibility of making progress. Non-timber forest products (NTFP) appeared with modest impact but high feasibility. Reforestation and forest product marketing fared moderately on both the accounts.

The overall goal for research in the forestry sector is to provide benefits to PICTs from improved forest management and conservation. The principle objectives of forestry research in the Pacific region are to enhance profitability of forest production through better understanding of the properties and market potential of lesser-known species (LKS) and through effective technology to meet quarantine export requirements.

Other objectives are to assist communities to re-establish forests to meet their needs with special emphasis on indigenous species; improve forest productivity through the management of pests and diseases present in countries and through prevention of pest and disease incursions; develop the potential of known NTFPs through better understanding of their properties, their uses and their economic significance; develop more effective production and marketing systems; develop appropriate agro-forestry systems especially for atoll environments and to integrate forestry with other land uses; and support sustainable natural forest management through development of soundly based inventory, growth and yield models.

Fisheries

Aquaculture feeds and feeding was assessed as having high potential impact and feasibility for the fisheries sector. Reef fisheries status assessment was regarded as having the highest potential impact but there are concerns about the feasibility of making progress. The feasibility of developing "turnkey" aquaculture systems is high although the potential impact on the fisheries sector is moderate. The feasibility of determining sustainable catch rates, developing standards assurance and affecting the integration of reef management with government systems were assessed as being low. Aquatic bio-security fared only moderately on both the counts.

The principle objective for research in the fisheries sector is to develop local alternative feeds and feeding systems, which can fatten fish with minimal by-products. Other objectives include developing appropriate aquaculture for the Pacific sub-region; providing information for communities and Governments on the exploitation and potential of natural reef fishery resources; certifying quality for sustainable export markets, especially in Asia; developing the capacity and policies to handle the potential threat of disease transfer and assess the impact and mitigate the effect of introduced species; integrate the separate community and government systems of traditional and national laws; and set reference points for setting targets for maximum catches in reef fisheries.

Natural Resources Management

The likelihood of making progress for all the NRM issues was assessed as either medium or low, the reason being limited research capacity in this area. Soil fertility, water management and integrated NRM were all assessed as having high potential impact. Farming systems research appeared to be moderately faring. It is interesting to note the relatively high importance accorded to waste management among the livestock issues as opposed to other NRM issues.

The principle objectives for the NRM sector are to establish an integration mechanism and develop sustainable integration between bio-physical, economic and soco-cultural/environmental factors, develop soil fertility, water (including irrigation) management practices especially for atolls; provide policy assistance for waste management; and develop a strong regional network of experts in soil fertility and water management. Management of nutrients, soil physical degradation, soil and water pollution, restoration of depleted nutrients, increased bio-diversity are the other areas of focus.

Cross-Cutting Issues

Information packaging, access and use and production and marketing economics were both assessed as having high potential impact and feasibility. While NRM policy, supply and demand analysis were assessed as having high potential impact with the feasibility of making progress was thought to be lower to moderate. Other research issues such as policy research into import-export, biodiversity, risk management and treaty incompatibility emerged as having only moderate impact and low feasibility of accomplishment.

The principal objective for research on the cross-cutting issues are to build capacity to assemble, access and use information and overcome the lack of information on the economics of production and marketing, and understanding of markets and supply and demand responses. Other objectives are to formulate and implement biodiversity policy; develop and implement import and export policies in PICTs as well as standards for domestic trade and research, and develop proper management principles for natural resources management in forestry, agriculture and fisheries.

Some Observations

1. Lack of or inadequate research capacity was found to be the most constraining factor under the feasibility criterion while scientific potential was not an important consideration.
2. Under the criterion of impact, both potential benefits and likelihood of adoption appeared to have reasonably contributed in determining the impact.
3. Human resources highlighted as the constraint in the livestock area, and also appeared to be the consideration with regard to capacity and adoption likelihood rather than research issues *per se.*
4. Issue such as "integration" appeared under a number of research areas with different emphasis, as this issue is seen in different contexts/perspectives within these different research areas. It is interesting to see where this issue sits in comparison with other issues in each of the research areas.
5. Agricultural engineering and mechanisation were not considered; this omission should be corrected during future deliberations on priorities.
6. The deliberations did not list high priority research issues for individual countries, as this was a sub-regional priority setting exercise. It would be desirable to revisit the country papers and to have further consultation with the country participants, and to link country priorities to the regional priorities established at the workshop.
7. Limited time did not allow intensive synthesis of published material though some of the participants were familiar with the published material and have had drawn on that to reach their conclusions. An annotated bibliography of this material is given in Appendix 3 and, that will provide a valuable reference point for future work.
8. The terms "Food Security" and "Sustainability" were used with subjective meaning and connotation, reflecting a general lack of awareness within the region of global understanding and consensus on these issues.
9. Priorities emerging from this exercise will provide broad strategic directions that can be followed in the short to medium terms for developing and implementing research projects. The framework established may also be used as a basis for improving analysis at regional and country level.
10. However, further analysis will be needed to decide on long-term implementation plan and directions. Such analyses should include developing research capacity in order to attend to high potential impact research areas and issues, which cannot be attended to in immediate future because of the limited research capacity.

Follow-up Actions Arising from the Pacific Workshop

The main follow-up actions to the Workshop include:

1 Presentation of the methodology and results of the workshop to the next APAARI meeting to be held in November 2001 (Dr R.D. Ghodake).

2 Providing feedback to the participants from the APAARI meeting and keeping them informed of the progress made by APAARI in advocating the importance of agricultural, forestry and fisheries research for the Pacific region (Dr R.D. Ghodake and other APAARI members from the Pacific).

3 Providing the country papers and workshop report to national stakeholders and donors to improve commitment to the identified priorities (country participants).

4 Using existing networks and the workshop taskforces to initiate regional activities where it is sensible to do so (existing Networks and SPC).

5 Rebuilding the information network and initiate training of librarians for the region (Librarian with SPC).

6 Providing the workshop outcomes to APAFRI and promote the outcomes to the forestry network (Forestry Task Force in SPC).

Feedback from the APAARI Meeting

The above methodology and results were presented at the Sixth Executive Committee Meeting of APAARI and Expert Consultation on ARD Priority Setting, held from 12 to 13 November, 2001 in Bangkok, Thailand. A small working group comprised of Dr Fernando Chaparro - Executive Secretary of GFAR, Dr Stein Bie – Director-General of ISNAR, Dr D. Baskaran of APAFRI, Dr Ramanath Rao of IPGRI, Dr Ian Bevege of ACIAR, Dr R.D. Ghodake of PNG-NARI, Mr Jainendra Kumar of Fiji, and Mr Albert Peters of Samoa further synthesised priorities identified at the Pacific workshop. The working group came out with the following refinements, which were presented, at the plenary session of the APAARI meeting.

High Priority Research Areas and Issues

The working group unanimously agreed and supported the strong emphasis placed by the Pacific workshop on the research areas of natural resource management and crops, and further agreed and put the selective emphasis on the research areas of livestock, forestry and fisheries.

The working group considered the priorities assigned by the Pacific workshop and decided to select high priority research issues that have high impact and high feasibility and that have high impact and medium feasibility. Some issues were reassessed and reassigned as high priority issues as explained in the parentheses. The results are presented in Table 7.

With respect to NARS and NARS collaboration, NARS in the Pacific sub-region should continue their collaboration activities through SPC in developing and implementing projects and networks, such as TaroGEN, SPRIG, SPYN, Fruit Flies, etc.

With respect to NARS collaborations with IARCs, it was suggested to continue and strengthen the current activities as follows:

- IPGRI – Pacific PGR with support from Australia/New Zealand funding.
- INIBAP/COGENT – Commodity linkage in Banana/Coconuts.
- ICLARM – Implementation of the SPC Aquaculture Strategy.
- CIP – Potato/Sweet potato research and development.
- IRRI – Rice and farming systems integration.
- CIMMYT – Maize introduction and improvement.
- IWMI (IBSRAM Pacific Land Network) – land, water management.
- AVRDC – Introduced and traditional vegetables.
- ICRAF – Agro-forestry on atolls.
- ICRISAT – Peanuts and Pigeonpeas.
- ISNAR – Capacity building – research managers and senior scientists.

Table 7: High priority research issues for the Pacific region

Research Area	High priority research Issue
1. Crops	1. Value adding
	2. Markets and marketing
	3. Plant genetic resources
	4. Pest and diseases
2. Livestock	1. Feed formulation and development
	2. Animal waste Management
	Livestock improvement (introduction and selection, excluding breeding)
	3. Zoonoses (research issue with high impact but low feasibility was reassessed as high priority)
3. Forestry	1. Timber utilisation
	2. Felling/cutting cycles in natural forest management
	3. Forest plantation health
	4. Agro-forestry for atoll environments
4. Fisheries	1. Aquaculture systems management (high feasibility aquaculture area was merged with aquaculture systems management)
	2. Reef fishery systems management
5. Natural resource management	1. Land management and soil fertility
	2. Watershed management
	3. Integrated NRM (research issue high impact but low feasibility was reassessed to be of high priority)
6. Cross-cutting Issues	1. Information packaging, access and use
	2. Production and marketing economic analysis (micro analysis at farm level)
	3. Supply and demand analysis (macro analysis at industry level)
	4. Natural resource management policy (Research issue with medium impact and low feasibility was reassessed as high priority issue)

It is further suggested to ensure effective co-ordination among IARCs and NARS so as to be cost efficient (reduced transaction cost).

Most national research and development programmes in the Pacific have limited involvement of NGOs and private sectors. It is necessary to involve all development partners as extension activities are highly dependent on NGOs and civil society (churches and women groups).

From Priorities to Proposals

The following steps are suggested to move from priorities to research proposals:

1. Analyze the current research and development portfolios and identify gaps (i.e. priorities not being worked on).
2. Determine whether research area is currently covered by existing projects/networks, etc. and explore possibility of strengthening these existing activities better to meet the priority needs.
3. For new proposals, identify most appropriate R and D providers among NARS, regional organizations and IARCs and establish collaborative partnerships.
4. Identify likely funding sources within the sub-region and donors.
5. Develop proposals following potential funders' guidelines and submit proposals.

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Agricultural Research Priorities for the Asia-Pacific Region

APAARI SECRETARIAT

This chapter sums up the conclusions and recommendations of the Plenary Session of the APAARI Expert Consultation on Regional Priority Setting for Agricultural Research for Development in the Asia-Pacific Region held at Bangkok from 12-13, November 2001. The conclusions have been organized around three basic issues (a) region-wide priorities shared by the three sub-regions; (b) inputs to the current process of selecting Challenge Programmes; and (c) next steps in going from regional priorities to concrete action proposals.

A comparative analysis among sub-regions led to the identification of seven common areas for research opportunities, that were considered to be the regional priorities. Five of them are related to broad research areas, while the last two are cross-cutting support activities that are important for agricultural research in general. These regional priority areas are:

1. Natural resource management
2. Genetic resources
3. Commodity chain development
4. Meeting the protein demand of a growing population
5. Tree and forest management
6. Cross-cutting issue: Information and communication management
7. Cross-cutting issue: Capacity development

These seven regional priority research areas were further broken down into more specific priority research themes within each research area, that were derived from the comparative analysis of the three sub-regional reports. This information is presented in Table 1.

Input into the Selection of Challenge Programmes

The second main issue was related to the inputs that APAARI can provide to the current process of selecting Challenge Programmes (CPs), being carried out by the CGIAR. The regional input into this process is being envisaged in two steps. The first one is to make a contribution to the selection of two or three topics/themes from the list of 10 that were recently discussed at AGM-2001 in Washington, in order to have the Asia-Pacific regional priorities reflected in those two or three initial cases that will be selected in the short term by the CGIAR. The second step is to generate new or additional ideas that may be derived from the Asia-Pacific regional priority setting process, and present them for the consideration of the CGIAR as *"new proposals"* for Challenge Programmes (CPs), through the Science Council. This is in response to the "call for ideas" that the CGIAR Executive Committee made in its first meeting. In this way, the APAARI regional priority setting process could make an input in setting the global ARD agenda.

After discussing the possibility of selecting the "top three candidates" from the list of ten topics currently being considered for CPs, as seen from the perspective of the Asia-Pacific regional priorities (Table 1). It was felt better to correlate how the ten CP proposals relate to the seven regional priorities

Table 1: Regional Priorities for the Asia-Pacific Region

1. Natural Resource Management
   - 1.1 Integrated NRM and Integrated Crop Management (ICM)/IPM
   - 1.2 Policy development and institutional issues related to NRM
   - 1.3 Watershed management
   - 1.4 Land management and soil fertility
   - 1.5 Rehabilitation of degraded and marginal lands
2. Genetic Resources Enhancement and Agrobiodiversity Conservation
   - 2.1 PGR conservation and improvement
   - 2.2 Livestock selection and improvement (includes fisheries)
   - 2.3 Microbial functional agrobiodiversity
   - 2.4 Bio-safety issues/policy/GMOs/IPRs
3. Commodity Chain Development (Linking Farmers to Markets)
   - 3.1 Commercialisation, marketing and trade
   - 3.2 Policy – International agreements
   - 3.3 Input/supply and demand analysis (industry and macro level)
   - 3.4 Production and marketing economic analysis (firm/farm and micro level)
   - 3.5 Value adding
   - 3.6 Competitiveness
   - 3.7 Product/quality improvement and standards
   - 3.8 Quarantine and bio-security
4. Meeting the Protein Demand of a Growing Population (Animal)
   - 4.1 Feed resources: fish, poultry, ruminants and non-ruminants (forage, pasture, fodder, grain, constituted feedstocks and crop residues)
   - 4.2 Disease management (poultry, ruminants, non-ruminants, aquaculture)
   - 4.3 Production systems (crop/livestock, aquaculture, mariculture)
   - 4.4 Waste management and by-product utilization
5. Meeting the Protein Demand of a Growing Population (Plants)
   - 5.1 Grain legume productivity improvement
   - 5.2 Legumes in farming systems
   - 5.3 Quality and nutrition improvement (human)
   - 5.4 Food safety: aflatoxins and anti-nutrition factors
6. Tree and Forest Management for Landholders
   - 6.1 Natural forest management:
     - Harvesting regime and regeneration
     - Cutting cycle analysis
   - 6.2 Forest plantation, productivity and health
   - 6.3 Agro-forestry in production systems
7. Cross-cutting Issue: Information Management for Agricultural Development
   - 7.1 Packaging, access and use: Research, methodologies and modalities
8. Cross-cutting Issue: Capacity Building
   - 8.1 Human resources development
   - 8.2 Institutional development
     - Research management, stakeholder management
     - Technology transfer facilitation
   - 8.3 Research policy development:
     - Food insecurity and poverty mapping

that were identified. In doing this analysis, it was observed that seven of the ten CP proposals are closely related to the seven APAARI regional priorities; in some cases, a CP proposal is related to more than one regional priority, as can be seen in the summary information presented in Table 2.

APAARI on behalf of the region would transmit this congruence of regional concerns as reflected in the areas of research opportunity, with the Challenge Programme proposals to the CGIAR, and express a strong desire of the region's needs to be considered in choosing specific Challenge Programmes for project preparation, and in regional context to be actively involved in both the design and implementation of the respective CPs.

Next Steps

The third main issue analysed was that of the identification of the next steps to be carried out in order to convert the regional priorities mentioned above them into concrete action proposals. Five main steps were identified:

a) ***Gap Analysis:*** Analyse current portfolio of regional research networks and regional cooperation programmes to identify congruence or differences with regional priorities. From this analysis it should be feasible to identify which regional and sub-regional priorities (see Table 1 and sub-regional chapters) are being addressed by existing regional networks and cooperative programmes, and which priorities are not being worked out (gaps between present collaborative efforts and regional needs/ priorities).

b) ***Implications for existing regional networks and regional collaborative programmes:*** The second step is to make a critical assessment of the existing regional networks and other modes of regional cooperation in agricultural research and development activities, in order to determine to what extent they have the capacity to address the gaps by adjusting and/or strengthening their activities better to meet the priority needs of the region.

c) ***Development of new proposals for regional and/or global collaboration:*** The gap analysis mentioned above will also identify those topics/themes that are not being covered by existing regional networks or projects, and that should lead to new proposals for collaboration at the regional and/ or global level. In order to operationalize these ideas and to convert regional priorities into concrete action proposals, a core group of institutions/stakeholders interested in the respective topic should be identified along with a lead-organization, who will be responsible for taking further action and develop a viable and feasible project or action proposal. This process should involve collaborative partnerships among NARS, IARCs, NGOs, farmers' organizations, regional organizations and other stakeholders (Table 3). At the global level, these ideas could lead either to new proposals for Challenge Programmes, or for Global Partnership Programmes along the lines that GFAR is facilitating.

d) ***Funding Strategy for each new proposal:*** Any new proposal should be based on a viable and sustainable funding strategy. Given the constraints in ODA (donor) funds available, these new proposals should be strongly based on cost-sharing among partners/stakeholders, who are sufficiently interested in the proposed initiative that they "buy into it" by contributing to its funding. At the same time, the requirements for the additional funding support that is required from donors should be clearly established, along with the identification of the potential regional and global donors. It is important that the collaborative programme can be assured through self-funding by the stakeholders as it will be easier then to mobilize the additional funding from donors.

Table 2: APAARI Regional Priorities and CP Proposals

Regional Priorities	CP Proposals
1. NRM	Water and Agriculture Desertification Climate Change Mountain Agriculture
2. Genetic Resources	Climate Change Biofortification Global Genetic Resources and Genomics Mountain Agriculture
3. Commodity Chain Development	Biofortification
4. Meeting the Protein Demand	Animal Health and Production Mountain Agriculture
5. Tree and Forest Management	Water and Agriculture Desertification Climate Change Mountain Agriculture
6. Information Management	A common issue to all CPs
7. Capacity Development	A common issue to all CPs

Table 3: Proposals for CGIAR Challenge Programmes (CPs)

Proposed CP	Proponent Institution (s):
Climate Change	ICRAF
Agriculture and Combating Desertification	ICRISAT, ICARDA
Global Genetic Resources: Conservation, Management and Improvement for Food and National Security, Agrobiodiversity and Sustainable Livelihoods (includes Genomics)	IPGRI, CIMMYT, IRRI
Water and Agriculture	IWMI
Biofortified Crops to Combat Micronutrient Malnutrition	CIAT, IFPRI
Animal Health, Market Access, Food Safety and Poverty Reduction	ILRI, IFPRI, OIE, FAO, WB, ICLARM
Global Mountain Programme	CIP, ICRAF, ICIMOD, CONDESAN
Global Initiative on HIV/AIDS, Agriculture and Food Security	ISNAR, IFPRI, WARDA, FAO
Challenge Programme for Sub-Saharan Africa	FARA
Development of Sustainable Agricultural Production Systems in Central Asia and the Caucasus (CAC)	ICARDA and CAC Regional Forum

e) ***Preparation of Guidelines for the development of proposals:*** It was pointed out that in order to facilitate the above process, it was important for any stakeholder interested in presenting a proposal for a "new initiative", either at the regional or the global level, to take into consideration the guidelines that potential donors have. This information is available from funding organizations.

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