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GCARD Regional Review for Asia Pacific: South Asia Report

Prioritizing the agricultural research agenda for Asia Pacific: Refocusing investments to benefit the poor

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GCARD Regional Review (South Asia Report)

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Foreword

The sub-regional report aims to contribute to the preparation of Regional Report on the Asia-Pacific region towards Global Conference on Agricultural Research for Development (GCARD) that will take place in March, 2010.

The Report reviews recent documents in the public domain. We have given importance to the most recent documents relating to the Terms of Reference of the task assigned to us. However, availability of needed documents, data and limited time to prepare the report constrained report preparation and submission. Standard methodology is used for commodity/commodity group prioritization of agricultural research for development in South Asia. The views expressed during the e-consultation are used for prioritization of overarching issues for agricultural research for development. In the Face to Face meeting, areas that require specific investment were identified. All these are provided in the report. In view of space restriction on the size of the main report, supporting details are provided in the appendices which may be referred to for more information. The help and guidance provided by Dr. R.S. Paroda, Dr. R.B. Singh, Dr. Ajit Maru, Dr. A.K. Bawa, Dr. Lourdes Adriana, Dr. S. Attaluri, Dr. Simone Staiger-Rivas and all the stakeholders who participated in the e-consultation and F2F meeting at Bangkok are gratefully acknowledged..

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Acronyms and Abbreviations

ADB	=	Asian Development Bank
AgGDP	=	Agricultural gross domestic product
APAARI	=	Asia Pacific Association of Agricultural Research Institutions
AR4D	=	Agricultural research for development
BARI	=	Bangladesh Agricultural Research Institute
CSIR	=	Council of Scientific and Industrial Research
CSOs	=	Civil society organisations
DARE	=	Department of Agricultural Research and Education
F2F	=	Face-to-Face
FAO	=	Food and Agriculture Organization
FBL	=	Final baseline
FCDS	=	Food characteristics demand system
GCARD	=	Global Conference on Agricultural Research for Development
GDP	=	Gross domestic product
GFAR	=	Global Forum for Agricultural Research
GMOs	=	Genetically modified organisms
GOI	=	Government of India
ha	=	Hectare
IBL	=	Initial baseline
ICAR	=	Indian Council of Agricultural Research
ICM	=	Integrated crop management
ICRIER	=	International Council of Research on International Economic Relations
ICTs	=	Information and communication technologies
IGP	=	Indo-Gangetic Plains
INR	=	Indian Rupee
IPM	=	Integrated pest management
IPRs	=	Intellectual property rights
MBL	=	Modified baseline
MSP	=	Minimum support price
MT	=	Million tons

NAIP	=	National Agricultural Innovation Project
NAP	=	National Agricultural Policy
NARC	=	Nepal Agricultural Research Council
NARS	=	National Agricultural Research System
NCAP	=	National Centre for Agricultural Economics and Policy Research
NGOs	=	Non-governmental organizations
NREGA	=	National Rural Employment Guarantee Act
NRM	=	Natural resource management
PFDS	=	Public foodgrain distribution system
PL	=	Poverty line
PPP	=	Public-private partnership
RNR	=	Renewable natural resources
SAARC	=	South Asia Association of Regional Cooperation
SAUs	=	State agricultural universities
TFP	=	Total factor productivity
UNU	=	United Nations University
USD	=	US Dollar
VOP	=	Value of production

Executive Summary

The Global Forum on Agricultural Research (GFAR) in collaboration with the Consultative Group on International Agricultural Research (CGIAR) aims to reshape the global agricultural research agenda for development and re-orient it to the needs of the poor through agricultural research synergized with adequate and rapid supply of agri-services. The effort is supported by Asian Development Bank (ADB) and Asia-Pacific Association of Agricultural Research Institutions (APAARI). The process consists of preparation of regional reports incorporating feed back from well structured and widely organized e-consultations with all the relevant stakeholders in the region and face-to-face regional and global consultations. The report on hand deals with South Asia which also includes the main feed back (voice of the stakeholders of the region) from e-consultation spanned from September 1 to 24, 2009 and F2F meeting held during 30-31 October, 2009.

South Asia comprising the countries of Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka has shown impressive growth of about 6.5% annually during 2001-06 owing to adoption of pro-growth policies. Rapid growth has significantly contributed to reduction of poverty as well. Progress in human development index is also observed. Notwithstanding these positive developments, South Asia still tops in the home of the poor in the world with about 400 million below poverty line people. The numbers of undernourished, under-weight and under-height children, and of low birth-weight infants in the South Asian region are substantial. There has been a rising inequality within and among the countries of the region. Agriculture is the main source of livelihood of people in these countries. Despite impressive GDP growth in agriculture in recent years, dependence of people on agriculture as a principal occupation has seen very little decline. Disparity between per worker income in agriculture and non-agriculture sectors is the main source of income inequality in South Asian countries. Further, agricultural productivity has considerably slowed down and further increase in productivity requires more and more use of expensive external inputs like fertilizer, plant protection chemicals, machinery, etc. There has been stagnation or deceleration in total factor productivity growth in majority of crops/enterprises. Technological breakthroughs are not visible owing to unfavourable, declining, degrading soil-water ecosystems, enhanced biotic and abiotic stresses, significant post-harvest losses, dwindling national and global funding support to agriculture in general and agricultural research and education in particular, restrictive knowledge-sharing opportunities, stagnating capacity and skills, uncertain policy support, collapsing service and support system and indifferent, inefficient and non-supportive governance system. Combined with these are deplorable basic facilities like health, sanitation, literacy, which have made rural life highly miserable, and agriculture unrewarding. New opportunities are also emerging in the form of demographic advantages (more young people), new technologies (biotechnology, nanotechnology, information technology), diet revolution and changing demands, emerging

value chains and super markets, entry of private sector, etc. Above all, the recent dramatic rise in the prices of basic foods has sent a shock wave through the world community, particularly poor people, arousing individuals and institutions from years of complacency about the state of the agricultural sector. Numerous studies have shown that investments in agricultural research typically rank first or second in terms of returns to growth and poverty reduction, along with investments in infrastructure and education. Fortunately, there is a consensus and also action in these countries towards higher investment in agriculture and related areas. The obvious questions in this context are how much this investment should be and where should it be focused.

The organization and management of agricultural research in the form of National Agricultural Research Systems (NARS) in these countries is at different stages of evolution. Some NARS like in India and Pakistan, are relatively large and strong whereas, in others they are weak. Over the years, they have tried to respond to the changing contexts by re-orienting their structure, functioning, priorities and activities. Some of these countries, particularly India, has made systematic efforts in agricultural research prioritization and utilised the results for research resource allocation. The efforts of APAARI in guiding the research prioritization process in the region are also significant.

Over the years, commodity, regional, within the countries, sub-regional, and Asia Pacific region priorities have been defined through consultations as well as using standard prioritization methodologies. The results from this empirical exercise suggest that (a) cereals, horticulture, livestock and fisheries in commodity groups and rice and milk as commodities should receive greater attention in resource allocation at South Asia level with certain minor variations among the countries, (b) prioritization exercises need to explicitly target poor as otherwise their needs are under-funded, and at least 2-3 times (if the AgGDP growth is assumed at 2.1%) and 3-4 times increase (if the AgGDP growth is assumed at 4%) in funding support in these countries to agricultural research and education to attain food and nutritional security and social empowerment. The uniqueness of the analysis is that it has used standard methodology commonly understood by decisions makers, poverty focus, demand driven approach and estimated the research investment needs to sustain food and nutritional security and social empowerment. Four percent growth in agricultural GDP can only be achieved with greater emphasis on the development of livestock, horticulture and fishery sectors. The feedback from e-consultation suggest the over-arching non-commodity based priorities as NRM, socio-economics and policy research, germplasm collections, conservation and improvement, strengthening of NARS institutions, strengthening of basic and strategic research in frontier areas of agricultural sciences, major focus to be given to upgrading the skills of farmers and change agents, follow participatory action research in value chains and sustainable livelihood security, more investment on education, roads, markets, power supply, communication, health and sanitation services, strengthening farmers' organizations including aggressive strategy to involve private sector, and effective management of service and support system, safety net and income enhancement programmes and better governance and political will and commitment in general. Besides these, the F2F meeting identified specific investment areas requiring additional attention which include (a) Farming systems approach in ecosystem

framework to pursue diversification (livestock, horticulture, fisheries), (b) Focus on women and youth in agricultural research, (c) Inclusion of local crops, along with wheat, rice and pulses as priorities, (d) Involve progressive successful farmers, NGOs and private entrepreneurs in technology transfer, (e) Address impact of climate change on agricultural production (f) Develop contingent plan for natural calamities, (g) Focus on post-harvest management, value addition, quality improvement and safety, (h) Improve risk management capacity by suitable farmer friendly policies, programmes and business models, (i) Linking farmers with market through value chain approach, (j) Policy dialogue with effective communication, (k) Blending modern technologies, innovations with proven indigenous technologies, and (l) Exploring income and employment opportunities beyond agriculture in rural areas. If these recommendations are attended, the growth in SOUTH ASIAN countries will be not only faster but also inclusive.

Chapter 1

Existing Needs and Recommendations

1.1 Review and Synthesis of Development Priorities in which Agriculture and Food Play a Role

South Asian economies comprising the countries of Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka grew rapidly at an average GDP growth rate of about 6.5 percent annually during 2001-06 owing to adopting pro-growth policies like opening up markets for international competition, public-private sector partnership, and improved macroeconomic management. The South Asian countries, particularly Sri Lanka, Bangladesh, Maldives, and Nepal, had also sought international development assistance to augment their own resources for development, though such assistance is declining over the years. Except Nepal and Sri Lanka, total GDP of other South Asian countries increased by more than 5 percent per year during the first 6 years of the 21st century. The GDP growth rate was more than 7 percent for India, Bhutan, Maldives and Afghanistan. Rapid growth has been instrumental in reducing poverty in South Asia. Progress has improved the human development index and related indicators. Further, the impressive growth has been accompanied by rising inequality between regions within the countries and among the countries. However, South Asia still tops the home of poor in the world with about 400 million below poverty line (USD 1 per day) people. The number of undernourished people and their proportion to the total in the world provide yet another ugly face of human misery in the region. The percentage of under-weight and under-height children and of under-birth weight infants in South Asia is unacceptably high. The rapid exploitation of natural resources and frequent and severe natural disasters like droughts and floods leading to a significant loss in GDP of these countries, are threatening the sustainability of productivity, income and quality of life of people in the region. These developments as rightly captured in the millennium development goals to free a major portion of humanity from the shackles of extreme poverty, hunger, illiteracy and disease, go well beyond improvements in growth, income and output to target quality of life-covering improvements in sanitation, health and nutrition, education, ecology and environment, and reduction in gender and income inequalities. The poor suffer most under these adversities. Thus, the major challenges of the region, more complicated than ever before, are: can it grow even faster and can the growth be inclusive. The study on the sources of economic transformation in Asia in recent years indicates neglect of agriculture and rural economy to usher in a sustainable and broad-based economic growth. The adequate and rapid solutions to the above challenges have to be through accelerated and inclusive agricultural development.

South Asia accounts for nearly 25 percent of the world population and 31 percent of the global agricultural population. But, it has only 6.3 percent of the world's agricultural land. Consequently, per capita availability of land is almost one-fifth in the region (0.38 ha) than

rest of the world (1.88 ha). About 80 percent of the world's small, marginal and sub-marginal farmers belong to this region, with an average holding size of less than one hectare.

Agriculture is the predominant sector of all South Asian countries. A vast majority of population in South Asian region lives in the rural areas and depends upon agriculture for livelihood and sustenance. The growth rate of GDP from agriculture during 2001-06 was lowest in Sri Lanka (1.2%) and highest in Maldives (6.3%). The GDP from agriculture was higher in 4 countries out of 7 countries during 2001-06 as compared to during 1991-2000. Despite rapid economic as well as agricultural growth of the some of the economies in the region, dependence on agriculture as a principal occupation has seen very little decline. Share of agricultural employment in total employment in all the South Asian countries is much higher than share of agriculture in GDP. Because of this difference, one worker in non-agriculture sector earns more than the income of 4 workers in agriculture sector in India, Nepal and Bangladesh. Disparity between per worker income in agriculture and non-agriculture sectors is the main source of income inequality in South Asian countries and is causing shifting of work force from agriculture to non-agriculture sector. The future growth of agriculture sector remains central to livelihood security, reduction of poverty and hunger, inclusive growth and sustainable progress and overall economic development of the economies in the region. It is widely reported that agriculture has special powers in reducing poverty. Cross country experiences show that GDP growth originating from agriculture is at least twice more effective in reducing poverty than GDP growth emanating from non-agriculture sector.

Notwithstanding the remarkable progress made in agriculture in 1960s in the form of green revolution, the sector is at cross roads now. Agricultural productivity has slowed down, with decline in growth in yields of most of the crops/enterprises in recent years. For instance, the productivity of rice in South Asia has reduced from 1.1% during 1970 to -0.2% during 2007; wheat yields are reduced from 2.79% during 1970 to 0.11% during 2007. Similar is the case in most of the other crops. It should be noted that area expansion to increase production is very limited in these countries since the availability of arable land has been considerably reduced. Further, increase in production requires more and more use of inputs leading to declining total factor productivity (TFP) and reduction in profitability per unit of inputs. The TFP growth rate for crops indicates a decline in majority of crops in South Asia. For example, in India for rice, TFP increased from 0.64% during 1971-86 to 1.08% during 1986-2000, whereas in the case of wheat, it declined from 1.28% to 0.68% during the same period. The decline is also seen in coarse cereals, pulses, fibers, sugarcane and vegetables. The TFP is declining in Indo-Gangetic Plains (IGP) for rice, wheat and crops as a group. Technological breakthroughs contributing to green revolution type quantum jumps in productivity are not much visible owing to unfavorable, declining, degrading soil-water ecosystems, enhanced biotic and abiotic stresses, significant post-harvest losses in commodities, dwindling national and global funding supports to agricultural research in particular and agriculture in general, restrictive knowledge-sharing opportunities, stagnating capacity and skills, uncertain policy support, collapsing service and supply system, and indifferent, inefficient and non-supportive governance system. The agricultural research

intensity ratios in these countries are much lower than the recommended level of 1% AgGDP. These concerns get compounded on account of major developments relating to unemployment, urbanization, globalization, climate change, IPRs, compliance to global treaties, energy crisis, and security threats owing to conflicts and violence and are impacting agriculture in a big way. All these combined with deplorable basic facilities like health, sanitation, literacy, etc. have made rural life in general and agriculture in particular most vulnerable and unrewarding, leading to extreme forms of social response like suicides and even expressing abandoning farming by farmers.

On the other hand, there are new opportunities to take advantage of, like the two key assets, demography (young labor force) and geography (highest population density in the world and second largest proportion of population living in the border areas), choice of advanced technologies, increased all round efforts for application of IT innovations in agriculture, diet revolution and changing food demands, emerging value chains and super markets, institutional innovations particularly involving private sector, globalization and greater public awareness, and involvement in political processes to elect good leaders. Some more details on the issues and opportunities for development in South Asian region are provided in Appendix 1

If agriculture has a strong record in development and agricultural research and education is central to that , then how to plan and implement agricultural research for robust development should engage priority attention. In this context, the new agricultural research agenda and the system require an entirely changed mindset, process reforms and institutional mechanisms so as to think out of box ideas/priorities.

1.2. Review and Synthesis of Existing Research Priorities in Agriculture and Food

The counties of South Asia have benefited significantly from investment in agricultural research. The green revolution during 1960s and 1970s consisting of use of high-yielding crop verities, fertilizers, irrigation and plant protection measures increased production of major agricultural commodities such as foodgrains, vegetables, fruits, milk, eggs and fish several fold. As a result, the per capita availability of important food items has increased many fold, despite increase in population. The increase in domestic agricultural production has also made a visible impact on the national food and nutritional security. However, poverty and malnutrition still continue to afflict more than one-fifth of South Asian population.

South Asian agriculture has dominance of small and marginal farmers. The ratio of agricultural land to agricultural population is about 0.38 ha/person in South Asia as compared to over 11 ha/person in the developed countries. With a global share of 6.3% land, 25% of population, the per capita availability of resources is 4-6 times less in South Asia than the world average. The pressure on limited land and water is getting further intensified with diversion of agricultural land, water and labour towards industrial, urban and non-agricultural sectors. Further, environmental impact on agriculture is getting pronounced in several regions and situations. Growth in total factor productivity is either stagnating or decelerating. The burgeoning population and rise in income level have led to increase in demand for not only

basic food requirements but value-added food products also. The increase in food production has to be achieved from the limited, diminishing and degrading resources. In this scenario, as witnessed in the developed countries, the role of science and technology becomes crucial to provide a competitive edge to South Asian agriculture.

However, all over the globe including countries in South Asia, the public research resources in agriculture are becoming inadequate in meeting the expanding research objectives and complex agenda for agricultural research, though investment intensity rose from a meagre 0.20% during early-1960s to about 0.50% in 2008. This, however, remains a way below the average for all developing countries. Since most of the agricultural R&D is in the public domain, it is necessary that each research dollar is spent efficiently. Thus, there is a need to optimally allocate the available scarce resources. The necessity is being felt on account of research resources size becoming large (which have alternate uses), aggressive participation in world trade, focus on high-value products, need for more equitable growth, greater attention to sustainability issues, etc.

Several formal, objective/subjective approaches for agricultural research prioritization in Asia Pacific region were attempted in the past, many of which were steered/guided by APAARI. Several research prioritization studies were made in India, mostly using modified congruence approach providing normative-relative research priorities in terms of regions (States in India) and individual commodities/commodity groups (Jha *et al*., 1995; Mruthyunjaya *et al*., 2003; Jha and Kumar, 2006). The efforts of APAARI for countries in Asia Pacific are also significant in identifying research priorities using quantitative and consultative approaches initially and quantitative approach lately (APAARI, 1996; 2002; 2005).

The APAARI efforts in prioritizing agricultural research have led to identification of seven areas as regional priorities (APAARI, 2002). Five of them are related to broad research areas, while the last two are for crosscutting support activities that are important for agricultural research in general. These regional priorities are:

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

The seven regional priority research areas were further broken down into more specific priority research themes within each research area (Appendix 2). The commodity research priorities identified by using modified congruence method are: cereals, livestock, cash crops, fruits, vegetables, plantation crops, oilseeds, pulses, fish, roots and tubers and dry fruits (APAARI, 2002)

The South Asia Association of Regional Cooperation (SAARC) comprises Government of eight countries of South Asia, namely, Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. It has developed a 'Vision 2020' document in 2008 (SAARC, 2008). The document visualizes how agricultural scenario would evolve in the near future and what policies and strategies would be appropriate to adjust to the emerging changes and harnessing their potential. The priorities in agriculture including agricultural research for different SAARC countries have been defined (Appendix 3), followed by stating the way forward. The way forward for the region as a whole, as stated in the Vision 2020 document includes accelerating agricultural output growth; strengthening of agricultural research, education and extension system; supply of adequate, quality seeds and other inputs; priority to increase production of foodgrains while promoting agricultural diversification; sustainable use of natural resources; addressing small size farm structure through creating suitable jobs in non-agriculture sector in and around rural areas besides other researches like contract farming, co-operative farming, adaptation to climate change through innovations in technology, institutions and policies, suitable strategies to harness potential of bio-energy crops and tree species, and development of technologies for utilizing agricultural wastes and surpluses for generating energy, favorable food price policy, emphasis on food safety and food standards, public-private sector participation (PPP), intellectual property (IP) management, biosafety and biosecurity, rural infrastructure development and above all, a strong regional collaboration.

In case of India, Jha and Kumar (2006) apart from identifying commodity and regional priorities, have identified current resource-orientation priorities also. Their study has revealed that nearly 35% of research resources were focused on germplasm, 26% on agro-chemicals and 21% on soil and water research. More than 55% were devoted to raising the productivity of natural resources. Material resources (agro-chemicals, power/machinery) all together claimed about one-third of the resources. The rest was spread across socio-economics and other resources. Their assessment of rationality of current allocation with the optimum arrived at through research prioritization indicates that all public R&D institutions follow this broad pattern. Private research is generally involved in tradable resources only. Hence, they have concluded that there is no alternative for public R&D for research on public good. Natural resources, HRD and institutional resources are the areas where private research has very selective interest domain, driven entirely by the product-specific interests.

1.3. Summaries of Recent Global Agricultural Developments/Agricultural Research Reviews

World Development Report 2008 (The World Bank, 2007) provides a detailed account of efforts made by countries and groups of enterprises towards agricultural development. According to it, in Asia, overcoming of widespread poverty requires confronting widening rural-urban income inequalities. Asia's fast growing economies remain home to over 600 million rural people living in extreme poverty, and despite massive rural-urban migration, rural poverty will remain dominant for several more decades. For addressing this, generating

rural jobs by diversifying into labour-intensive, high-value agriculture linked to a dynamic rural non-farm sector is important. With the rising land and water scarcity and the added pressures of a globalising world, the future of Asian agriculture is intrinsically tied to better stewardship of natural resources. With the right incentives and investment, agriculture can be made environment-friendly. Rapidly expanding domestic and global markets, institutional innovations in markets, finance, and collective action and revolutions in biotechnology, information technology, nano-technology all offer exciting opportunities to be used in agriculture for development. But, seizing on these opportunities requires the political will and reforms in governance of agriculture. The role of international community is to level the playing field in international trade, provide technologies for food staples, help developing countries and address climate change, and overcome looming health pandemics for plants, animals and humans. The governments and donors have to reverse the years of policy neglect and remedy underinvestment/misinvestment in agriculture. The assets of the poor households (land, water and human capital) have to be increased, to make smallholder's agriculture more productive and create more jobs and income opportunities in the rural non-farm economy.

It is estimated that to meet the projected demand, cereal production will have to be increased by nearly 50 percent and meat production by 85 percent from 2000 to 2030. To make small farmers' agriculture productive, improving price incentives and increasing the quality and quantity of public investment, making product markets work better, improving access to financial services, reducing exposure to uninsured risks, enhancing the performance of producer organizations, promoting innovation through science and technology and making agriculture more sustainable and a provider of environmental services become important.

To create a dynamic rural economy and upgrade skills to participate in it require a rapidly growing agriculture and a good investment climate, linking the local economy to broader markets by reducing transaction costs, investing in infrastructure and providing business services and market intelligence education, skills and entrepreneurship. These have to be fostered by providing incentives for parents to better educate their children, improving the quality of schools and providing educational opportunities relevant to emerging job markets. Providing safety nets and social assistance to the chronic and transitory poor can increase both efficiency and welfare while implementing an agriculture-for-development agenda is a challenge. It includes managing the political economy of agricultural policies to overcome policy biases, underinvestment and misinvestment and strengthening governance for the implementation of agricultural policies which gets low scores. The quality of implementation is critical and has to be improved enormously.

In the document, "Transforming the Rural Asian Economy: The Unfinished Revolution by Rosegrant & Hazell" (ADB, 2000), the efforts made by Asian countries to transform rural economies are examined and road map for accelerating the transformation is suggested. According to the document, the future of Asia is brighter. Both Asia and the world should be able to meet the projected food demand, at least in the aggregate. There should be a steady progress by the governments and the international community in devising and carrying out

policies which should include investment in agricultural research, extension, irrigation and water development, human capital and rural infrastructure. Besides, continued efforts towards market orientation and involvement of private sector renewal governance — transparency, responsiveness and eradication of corruption, are keys to sustained growth. The governments have to increase the level of productive investment made in rural infrastructure, agricultural research and extension, education and health as well as expand the reach of the social safety-net programmes. While the spectre of famine that hung over Asia in 1960s has not returned in the 1990s, widespread poverty and malnutrition still co-exist with great wealth. Completion of the rural revolution, radical reduction in poverty and improvement in food security in Asia hang in the balance. They are attainable, if complacency is resisted.

The CGIAR's Science Council (CGIAR, 2003) has listed 10 systems priorities with the intention of developing a more cohesive and better focused research programme. They are as follows:

1. Conservation and characterization of genetic resources
2. Genetic improvement of specific traits
3. Improved water management and use in agriculture
4. Better management and use of forests and forest land scapes
5. Better soil and land management and use
6. Improved production and processing systems for high-value commodities
7. Enhancing resource-efficient and equitable forms of livestock sector growth
8. Improved management and use of aquatic resources
9. Policy and institutional innovation to reduce poverty and hunger and to enhance competitiveness of smallholders
10. Strengthening national and regional capacities for agricultural research and rural institutions

CGIAR has also used congruence analysis with an optimum budget allocation derived from allocation of a normative formula embodying a number of criteria meant to achieve CGIAR objectives. Optimum resource allocation was established across commodities, sectors and regions for 19 crops plus livestock, forestry and fisheries and 5 geographical regions. Optimum budget allocations were determined on the basis of (a) the share of the activity and region in the total value of output (VOP), and (b) modifiers to these shares to account for considerations of poverty, participation of women, new scientific opportunities, alternative sources of research and probability of success. But over time, this approach has become increasingly incomplete owing to the growing diversities of activities of CGIAR such as basic science, natural resource management (NRM), socio-economics and policy, research management, training, etc. Clearly, budget allocation based on production value does not work well when priorities increasingly address issues that do not involve production of goods and services valued in the market place.

The approach followed for the 2003 prioritization and strategy (P&S) exercise complemented the traditional congruence analysis with a broad consultation on priorities with stakeholders and scientists. This exercise finally suggested CGIAR research resources

allocation of 30% to germplasm, 30% to sustainable systems and NRM, and 40% to policy and institutions. It was found that at these 3 aggregate levels, actual allocation was very close to the suggested allocation.

Though CGIAR forms around 4% of AR4D expenditure around the world, it intends to initiate the change process towards making investment in the research for development. In other words, it will link demand, research prioritization and institutional mechanisms and investments required for research to be able to achieve greater and more rapid impact against development objectives, not just research outcomes. This requires knowledge of the perspectives of international research, national research and many stakeholders involved in harnessing research into development impacts, in processes centred on the needs, demands and realties of the poor.

The review relating to priortization and strategy (P&S) for the CGIAR considers that the overall research priorities should conform to vision and strategy of CGIAR adopted in 2000 (CGIAR, 2003). The guidelines include priority given to sustainable poverty reduction, adopting a regional approach and pursuing partnerships. The priorities must also be consistent with CGIAR major undertakings, viz., germplasm conservation, germplasm improvement, sustainable production systems (NRM), socio-economics and policy research and enhancing NARS capacities. Since the previous approach to setting priority and strategies is increasingly becoming incomplete owing to the growing diversity of undertakings, a new approach is suggested to complement congruence with a broad consultation with stakeholders and scientists.

One of the steps towards this was organising 5 regional panels of stakeholders consultation in phases. Some results of the Asia Panel include enhancing germplasm through conventional approaches and biotechnology (20% weight), sustainable production systems (16%), strengthening of NARS and other rural institutions (12%), germplasm collection and conservation (8%) and improving policies (7%). The top priority of the Asia Panel was to operationalize an explicit poverty focus for the CGIAR. CGIAR should look for research priorities that may bear simultaneously on several dimensions of poverty, viz., lack of income (low consumption), vulnerability, hunger and food insecurity, ill-health and malnutrition, ignorance, inequities, low status of women, pollution and degraded environments, lack of sustainability threatening the welfare of future generations, social exclusion from social and political affairs, lack of market power, etc. The multidimensions of poverty require looking at rural development instead of only at agricultural development. This is a major redirection of the CGIAR's traditional research focus that should guide priority setting. In view of poverty becoming increasingly urbanized, agricultural research must aim at reduction of aggregate poverty. The second major thrust by the Asia Panel was on productivity enhancement. The tools and techniques of modern biology have to be used with better engagement with the private sector. Some of the research policy areas discussed requiring deeper research included diversification, decentralization, indigenous technical knowledge (ITK), the future of small-scale farming making the CGIAR more people centred than science

centred, insufficient attention to animal protein production relative to crop-based food energy and protein, etc.

The next theme was sustainability. Market failures and incentives relating to NRM were discussed. Many more policy and institutional studies are required. Careful priority setting in social science research for improved NRM is required. Risk and the level of risk-coping instruments need attention. New research tools like GIS which provide greater insights and opportunities for knowledge advance in NRM should receive attention. NRM area has many local public goods elements which contrast rather widely with such goods dealt by CGIAR so far. The next theme was institutional sustainability innovation systems. One of the major areas requiring attention was capacity building besides continued support to O&M reforms. The last theme discussed was on international competitiveness mainly arising from their labour costs as well as year-round-crops growing conditions in many areas. Support to strengthen marketing channels, quality control mechanisms, market intelligence systems, processing, storage and trading technologies will help improve competitiveness.

The global panel recommendations include conservation and utilization of knowledge (16%), raising the productivity and resilience of farming systems (15.5%), germplasm improvement through biotechnology and traditional methods (14.5%), developing research priority setting methods, maintaining and improving the efficiency of natural resources (11.5%), enhancing knowledge management and capacity of NARS (9.5%), projecting the impact of resource and climate change on agro-ecosystems and wild resource systems over the next 25 years. Thus, the stakeholders' consultation demands research on improvement of germplasm, work on collection and maintenance of genetic resources, research on improving the efficiency, resilience and sustainability of smallholder farming systems and more research on policies, institutions and markets in agriculture.

The discussion on the global panel recommendations suggested the CGIAR to assess the readiness and ability to adopt a pro-poor agenda as its main objective, restructuring the CGIAR into three areas, viz., (a) strategic research, (b) methodology development, and (c) capacity building as follows: Germplasm (40%), Resources (40%) and Policy (20%). The details of suggested Asian priorities recommended by the panel are annexed (Appendix 4). The overriding idea that emerged in the panel is that the CGIAR surely has a key role to play in achievements of the ambitions MDGs. The panel considered the following as the priority themes: Poverty, productivity, sustainability, institutional strengthening, and international competitiveness.

The draft CGIAR SRF (CGIAR, 2009) plans to attain the following results:

a) Lift annual agricultural productivity by an additional 0.5 percentage point to meet the food needs of the future world population and help to reduce poverty by 15 percent by 2020.
b) Contribute to reduction of hunger and improved nutrition in line with MDG1 targets, cutting in half by 2015 (or soon after) the number of rural poor who are undernourished, with a focus on child undernutrition.

c) Deliver these outcomes in more sustainable ways by using less water (through greater water productivity), halting or reducing the rate of further deforestation and soil degradation (through improved land management practices) and contributing to climate change mitigation and adaptation.

The building blocks of SRF are a set of 7 interlinked mega-programmes (MPs) and two platforms — gender and capacity strengthening that serve cross-cutting purposes for all 7 MPs. The MPs include crop germplasm consideration, enhancement and use, diets, agriculture, nutrition and health, institutional innovations, ICTs and markets, climate change and agriculture, agricultural systems for the poor and vulnerable, water, soils and ecosystems, and forests and biomass. To deliver these, CGIAR would aim at a budget outlay of US$ 1.4 billion, by almost tripling its current size.

Chapter 2

Current Implementation Mechanisms

The current institutional and infrastructural arrangements supporting agricultural development is presented below mainly drawing information from SAARC Perspective (DARE, 2000) and SAARC Agriculture Vision 2020 (2008) and Mittal and Sethi (2009). It is difficult to get the information for other countries than India.

The organization of agricultural research in general is almost on a similar pattern 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 that deal with research as well as agricultural universities for education and research. At the Centre, there is a Council to plan, co-ordinate 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 the oldest organization in the region (Mruthyunjaya *et al*., 2003).

Over the years, the public research organisations have satisfactorily addressed the research needs of their countries (Alston *et al*., 2000). It may be noted that in all these countries, the main objective of the research systems was attainment of food self-sufficiency, which has now been expanded with the addition of such objectives as equity, sustainability of natural resources, diversification of product mix, export promotions, etc. In terms of commodity coverage, focus has slowly expanded from research on crops to livestock, horticulture, fisheries, forestry, natural resource management and socio-economics and policy research. A similar expansion has taken place in the disciplines of agricultural sciences, and currently, the focus is on agricultural biotechnology. However, these developments widely vary across countries in the region.

The SAARC agricultural perspective (DARE, 2000) provides details of the structure and functioning of the National Agricultural Research Systems in particular and agriculture sector in general of the South Asian countries. A brief account of different SAARC countries is provided below.

Sri Lanka

Sri Lanka has a National Agricultural Policy (NAP) since independence. It is almost unchanged with emphasis on self-sufficiency in essential foods (mainly rice) and dependency on traditional exports such as tea, rubber, coconut and spices. The NAP 2004-2010 has emphasized on increasing domestic food production and self-sufficiency with the primary aim of reducing widespread poverty in the rural and estate sectors. It also emphasizes household food and nutritional security, sustaining environment and natural resources and

expanding rural employment. The Sri Lankan NARS consists of 12 main research institutes/ departments that operate under 6 Ministries — Agriculture and Livestock, Plantation Industries, Environment and Natural Resources, Fisheries and Ocean Resources, Tertiary Education and Training, and Co-operatives. The research investment is only 0.52% of Ag GDP. Although the NARS has developed sufficient capacity, it has not performed well and a decline in the quality is observed. Research institutes currently lack commitment and hard work. Increased motivation and commitment combined with more resources (at least 1% of AgGDP) will be helpful. Due to change in NAP, mandates of the research institutes have changed from production with emphasis on yield increases to post-harvest processing and value addition. The role of the private sector has diminished to a considerable extent with emphasis on farmers organizations as the focal point for implementation of production programmes. The fund allocation for agricultural research is based on the above priorities rather than on research projects. The focus is on cutting edge research in areas that have immediate impact such as biotechnology, plant breeding, post-harvest technology and labor-saving machinery and equipment.

Bangaldesh

The Bangaldesh Agricultural Research Council (BARC) was established in 1973 to provide impetus to more dynamic research in agriculture, including livestock, fisheries and forestry. BARC co-ordinates entire agricultural research effort in Bangladesh. It involves collaborative activities with several government ministries like Agriculture, Forests, Livestock and Fisheries, Education, and Industries and Commerce. It also collaborates with other organizations like extension departments, universities and development institutes in the country and with several regional and international organisations around the world committed to poverty alleviation and rural development. It co-ordinates 12 NARS research institutes. There is a network of regional research stations and substations under these institutions. These units work on regional and local problems and also conduct studies on the adoption of new technology in different agro-ecological areas. There is also on-farm research in which researchers work with local farmers who try out new practices under actual farming conditions. The linkage with extension service organizations provides the potential for the two-way flow of communication.

Bangladesh has also developed a National Agricultural Policy (NAP) for the development of agriculture to meet the emerging challenges of food security, high variability in rainfall, flood and drought, salinity, cyclones and tidal waves, soil fertility, maintenance of germplasm, hill agricultural research, rural infrastructure development, crop diversification, agricultural diversification, re-application of bio-mass and poverty alleviation and malnutrition.

Education in agriculture began in 1938 with the founding of Bengal Agricultural Institute (BAI) which is now the Bangladesh Agricultural Research Institute (BARI) with academic affiliation to Bangaldesh Agricultural University (BAU). Another college of agricultural sciences was established in the early-1983 which is now known as the Institute of PG Studies in Agriculture (IPSA), an independent institution with the status of a university. In addition, three other colleges have been offering degree courses in agriculture under BAU affiliation.

For providing agricultural extension service at grass root level, 11 Agricultural Training Institutes (ATI) have been conducting 3-year diploma courses in agriculture after secondary school certificate examination. Under the policy of the Government of Bangladesh, there is a 3-year degree of Bachelor of the Agricultural Education (B.Ag. Ed.) after higher secondary certificate in science through Bangaldesh Open University. The University of Khulna is offering a graduate course in Agriculture and Fisheries under the Department of Agro-technology and fisheries and marine biology disciplines, respectively. Besides, two new veterinary colleges and one private agricultural college have also been established.

In Bangaldesh, Department of Agriculture Extension is the leading extension provider. The Department maintains linkage with the farmers and provides technical support down to block level. The Department has more than 12000 Block Supervisors throughout the country. Other agencies who provide extension support to the farmers include Bangaldesh Rural Development Board, Bangladesh Water Development Board, Bangladesh Agricultural Development Corporation, Forest Department, Department of Livestock Services and Department of Fisheries. There are also many NGOs, commercial traders and input suppliers operating in the rural areas. All of these agencies can be seen as comprising the National Agricultural Extension System. A new agricultural extension policy has been approved. The formal institutional framework for extension research linkages consists of:

- Agricultural Technical Committees
- Research Institute Co-ordinational Committees
- National Agricultural Technical Co-ordination Committees

Nepal

Realising the importance of agricultural research, the Government of Nepal established Nepal Agricultural Research Council (NARC) in 1991 as an apex institution for policy co-ordination and implementation of agricultural research and development in the country. NARC has developed a 20-year vision (NARC Vision 2021) which outlines a broad strategy for addressing the agricultural research needs of Nepal. The major agricultural research priorities in the NARC Vision 2021 include field crops, horticulture, livestock, fisheries, and related natural resources issues and socio-economic aspects of the farming systems, price analysis and marketing, on-farm water management, agro-forestry, gender, and above all, policy research. NARC is promoting adaptive and applied research programmes that are need-based and demand-driven. Priority has been given to research topics generated from village level workshops participated by researchers, extension workers, development agencies and farmers' groups and supported by Regional Technical Working Groups (RTWGs). Presently, NARC is allocating research resources in priority themes and commodities identified by the long-term Agricultural Perspective Plan (1997-2016) of Government of Nepal and the NARC Vision – 2021.

NARC is conducting applied and adaptive research with a network of 12 technical disciplinary diversions (7 in crops and 5 in livestock), 14 commodity programmes (10 related

to crops and horticulture and 4 related to livestock) and 4 Regional Agricultural Research Stations (RARS) and 16 Agricultural Research Stations (ARS). The Institute of Agriculture and Animal Science (IAAS), Rampur, operating under Tribhuvan University system is the only institute for higher education in agriculture in Nepal. The Council for Technical Education and Vocational Training is also involved in agricultural education and training for field level minor technicians. The Department of Agriculture also operates an agricultural training network consisting of Central Agricultural Training Centre (CATC) and 5 Regional Agricultural Training Centres (RATC). These training centers are basically meant for on-job trainings for junior technicians and train farmers on specific crops and livestock production systems.

Department of Agriculture (DOA) and Department of Livestock Services (DLS) under MOA have been mandated and are primarily responsible for providing extension services to farmers. These departments have networks in all the regions and district levels scattered throughout Nepal. The emphasis of DAE and DLS has been on disseminating technologies by maintaining production targets and input delivery services.

Bhutan

In Bhutan, the establishment of systematic research is of recent origin, during 1993. The result was the change from the previous segregated, departmental approach to an integrated Renewable Natural Resources (RNR) focus, recognizing the interaction among crops, livestock and forestry in Bhutan's farming system. To this end, the separate research responsibilities of the Departments of Animal Husbandry, Agriculture and Forestry were amalgamated into one RNR programme co-ordinated by the Research, Extension and Irrigation Division (REID) of the Ministry of Agriculture. There are four RNR regional research centers. At the national level, each center acts as the focal institute for one or more disciplines including agriculture, pastoral, forestry and horticulture. Research undertaken is mainly adaptive in nature.

Extension services is decentralized in Bhutan. The smallest unit is the block which is staffed with an Extension Agency from Agriculture, Animal Husbandry and Forestry. National Extension Policy was formed in 1995. An integrated approach to agricultural extension is advocated. Focus has been on modest input and modest output. At the regional level, a research extension programme planning workshop on an annual basis is organised, where joint review of work is done and plan for new work is decided. Activities under joint collaboration between research and extension include on-farm research, farming system studies and survey-work. The research will be driven by the needs of farmers.

Maldives

In Maldives, the limited staff at the Ministry of Fisheries and Agriculture is a limiting factor for research and extension activities. There is a need to augment staff both at professional and technical levels. The agricultural activities are based mainly on helping the farmers in the most basic techniques and supplying them the required seeds and planting

materials. An organized agricultural research is virtually non-existent. There is no higher educational establishment in Maldives and suitable candidates are sent abroad for higher education in agriculture and other academic studies.

Extension is carried through demonstration centers and farm training courses in selected agricultural islands. It is difficult and costly to reach farming communities as the islands are scattered over a large area.

India

India has one of the biggest NARS in the world. It is led by the Indian Council of Agricultural Research which has 97 research institutes located across the country, 80 All India Co-ordinated Research Projects, and 17 research networks, one central Agricultural University and 5 deemed to be universities. Private sector research is mostly done by companies and they confine to areas where short-to-medium term gains are possible and where findings can be protected. Agricultural research is also carried out in certain IITs, general universities, CSIR laboratories, etc.

Agricultural education is generally managed through a network of 45 state agricultural universities (SAUs), five deemed to be universities, and one central university under ICAR. The main function of SAUs is to provide integrated teaching, and conduct research and extension at all levels, including provision of specialized non-academic training programmes for rural people. Their major activities are concerned with adaptive research. Research infrastructure usually consists of an agricultural experiment station at the main campus and a number of regional research stations and sub-stations. Many of them are multi-campus universities and virtually all of them have colleges of agriculture, veterinary science, home science, horticulture, etc. In recent years, new state universities have been established in Horticulture, Fishery and Animal Sciences.

The ICAR extension set-up includes Division of Extension at the Headquartes at New Delhi, 567 *Krishi Vigyan Kendras* (agricultural science centres) at least one in each of the rural districts and 8 zonal co-ordinating units. In addition, the Department of Agriculture and Cooperation of the Ministry of Agriculture is operating 252 Agricultural Technology Management Agencies (ATMAS) in selected districts of the country.

The ICAR has a strong programme of front-line demonstrations in collaboration with Ministry of Agriculture. ICAR from time to time has implemented several World Bank funded projects to undertake innovations in research, education and extension in agriculture. Presently, it is implementing National Agricultural Innovation Project (NAIP) since July, 2006 with several new innovations in research processes and products.

International Council of Research on International Economic Relations (ICRIER) has completed a study on "Food Security in South Asia: Issues and Opportunities" (Working Paper No. 240) by Surabhi Mittal and Deepti Sethi during 2009. The study has been conducted in the backdrop of a situation in agriculture in the South Asia Region (SAR) which is caught

in a low equilibrium trap with low productivity of staples, supply shortfalls, high prices, low returns to farmers and area diversification posing threats to food security in the region. The study conducted by eight country scholars from all the South Asian countries aimed at evolving a South Asian policy perspective on the food security. The paper states (Appendix 5) that the countries in the SAR face the challenges of rapid rise in population, declining farm productivity and lack of employment opportunities that translate into food insecurity. It states that all countries need to step-up their investment in research and development and extension services to increase farm productivity. Besides, investments on agricultural infrastructure such as irrigation and power, road networks also need to be stepped up to improve connectivity. The paper considers the tricky issue of tackling the tendency to move away from the cultivation of staples towards cultivation of other high-value crops. It involves a trade-off between rising farm incomes and meeting rising domestic demand for staples. It suggests an integrated strategy that includes productivity enhancing measures and appropriate pricing policies to create an incentive structure to strike a balance between the two objectives. It also suggests to strengthen social security system, well targeted distribution system to improve food access for the poor, increase in income of the poor by enhancing their asset endowment and create greater non-farm employment opportunities. It also suggests a shift from the present bias towards calorie based food security programmes to ones that address the issue of nutritional deficiency at regional level. It suggests increased agricultural trade whose benefits may be higher than setting up of the SAARC Food Bank. It strongly recommends for improved regional cooperation in the field of agricultural research and education, addressing climate change issues, trans-boundary diseases, etc. It suggests regional initiatives to end the endemic conflicts in the region which is also required to attain food security. The paper provides a good summary of major food security programmes being operated in South Asian countries (Appendix 6).

The white paper on priority framework for FAO in India (FAO, 2009) states that India has a diverse institutional set up, a centre-state dichotomy, and multiple agencies involved in the same tasks with weak accountability. On the basis of analysis of achievements, challenges and opportunities for India, it observes that the country needs higher order global skills to adjust to the changes in and around agriculture and to address the anticipated problems like climate change and energy stress. It further states that the country can learn and gain from improved agricultural practices, models of integration of small farmers in value chain and relevant success stories in other countries. Also, there are some problems like transboundary pests and diseases where India cannot act alone and where global or regional initiatives are required.

The Government of India (GOI, 2008) in its plan for poverty eradication in India by 2015 outlines a rural household centered strategy. The draft paper states that due to the inherent strength of economy, the impact of global financial melt down is expected to be much lighter than experienced by other countries. It has examined the features of rural poverty, its magnitude, trends and geographical distribution, past and present programmes for poverty alleviation and proposes interventions designed with rural households as a unit.

The paper notes the broad categories of poverty alleviation programmes as: (a) wage employment, (b) self employment and skill development, (c) rural infrastructure, roads, markets, housing, sanitation, drinking water, and (d) social security and safety nets and reports that over years several modifications have undergone. The paper has developed a strategic framework to eradicate rural poverty by 2015 consisting of 4 pillars: (i) generation of self employment in credit-linked micro enterprises and salaried employment in placement-linked, demand-driven skill development, (ii) wage employment, (iii) payment of pension to the elderly, weak and vulnerable sections of the Society, and (iv) about 51 income generation and social security programmes of 18 ministries /departments. The paper ends with a happy note that poverty eradication by 2015 is possible by implementing the proposed strategy which will ensure the achievement of the first goal of MDP, "eradicating extreme hunger and poverty." As can be seen, the programmes in India are many with diverse features, with successes in some cases and issues for resolution in others. Other countries in South Asian region can really learn form the experiences of India to decide about the number and nature of such programmes in their countries. In fact, the paper provides an assessment of their strengths and weaknesses along with suggestions for improvement in the agricultural sector.

Chapter 3

Ensuring the Needs of the Poor are Met

3.1. Key Areas for Addressing the Needs of the Poorest

The specific issues related to the role of agriculture for the poorest rural sectors in the region include the following:

(i) Raise investment in agriculture in general and agricultural research and education in particular

The evidences and arguments provided earlier in the report clearly establish the centrality of food and agricultural development to modernization of economies of the member countries, or in outlining strategies for agricultural development. The governments and donors have to reverse the years of policy neglect and remedy underinvestment in agriculture.

(ii) Raise productivity in agriculture

Continued importance of feeding the dense population in South Asian countries is felt with increasing numbers, growing urbanization, loss of agricultural land, increased competitions for water, and falling productivity of enterprises. Raising productivity is the enduring solution to this issue. Productivity has to be raised by 2 to 3 times in many cases.

(iii) Raise knowledge and skills of farmers and change agents

One of the effective ways to reduce/economise use of material inputs and increase profitability in farming is to increase knowledge input. Education is often the most valuable asset for rural people to pursue opportunities in the new agriculture, obtain skilled jobs, start business in the rural non-farm economy, and migrate successfully. The status of knowledge management is very weak (both in quantity and quality) in all the countries of the region of both farmers as well as change agents. The public extension system is nearly non-functional and their knowledge and skills particularly in sunrise sectors like horticulture, fishery, processing and post-harvest management, product quality and standards, market intelligence, weather advisory, etc. are grossly inadequate.

(iv) Raise employment and income

For addressing this, generating rural jobs by diversifying into labour-intensive, high-value agriculture linked to a dynamic rural non-farm sector is important.

(v) Build roads, develop markets, ensure energy security and improve rural health

Strengthening transport infrastructure and services in rural areas in general and improving road connections are critical to establishing the links of farmers and the rural economy to local, regional and international markets. Better markets for agricultural produce have broad implications for agricultural growth because they raise farm gate prices and allow farmers to diversify to high-value products. Improving and

modernizing the marketing systems will increase market efficiency, and competitiveness and reduce losses and risks. Rural energy has assumed critical importance as its supply is much lower than demand and therefore will increase agricultural production costs, placing upward pressure on food price. Widespread illness and death from HIV/AID, malaria, etc. can greatly reduce agricultural productivity and devastate livelihoods. Better co-ordination between agriculture and health agendas will yield big dividends for productivity and social welfare.

(vi) Develop supportive institutions and policies including adequate and effective safety nets

Institutional innovations and developments are required to address market failures, reduce transactions costs and risks and service gaps. Some progress has been made to fill the deficits in land markets, financial services, input markets and producer organizations. But, these are incomplete particularly for smallholders and poor situated in the vulnerable areas. More clarity on the roles of the state and the private sector and Civil Society Organizations (CSOs) is required. Safety nets are additional forms of income support to the poor and needy. These create welfare gains for recipients and have spill over effects on the education and nutrition of family members. To serve the intended purpose, safety nets need to be flexible, quick and efficient. It is important to note that the likelihood of success in using agricultural research for development can be enhanced through supportive policies relating to subsidies, market reforms, involvement and incentives for private sector participation, investment in R&D, infrastructure development, etc.

(vii) Conduct advance and anticipatory research

Scientific and technological innovation is fundamental for agricultural development in the face of rising resource constraints and energy costs, maintaining market competitiveness, improving livelihood security, particularly in less-favoured regions. Revolutionary advances in the biological, information and management sciences have the potential to shift the productivity frontier up and enhance the competitiveness of smallholders and overcome abiotic and biotic stresses in production systems. Countries have to invest in advance and anticipatory research to find solutions to the emerging complex problems. The institutional setting for technological innovation is changing fast, becoming more complex, involving plural systems and multiple sources of innovation. With the development of markets, which is essential for improving income of farmers, innovation becomes less driven by science (supply side) and more by markets (demand side). New demand-driven approaches stress the power of users — men and women farmers, consumers, and interest outside of agriculture in setting the research agenda and the importance of research in value chain.

(viii) Involve all stakeholders in planning and implementation of programmes

Innovation for the new agriculture requires feed back, learning and collective action. The involvement of all the stakeholders in planning and implementation of the project activities becomes important for building understanding, ownership and sustainability.

(ix) Provide able governance and political will and commitment

Governance is essential to realize the agendas of new agriculture for development. Governance problems can severely hinder development. It covers processes of democratization, civil society participation, agri-business development, public sector management reforms, corruption control and decentralization. The complexity and diversity of agriculture require special efforts towards governance. Three types of governance problems are important to be addressed – lack of macro-economic and political stability, political economy problems and state resource and capacity.

3.2 Key Areas Where Agricultural Research is being Proposed

The key areas for agricultural research are proposed on the basis of research prioritization done in this consultation, review of past efforts referred to earlier and feed back from e-consultation.

3.2.1 Research Prioritization

Research prioritization was attempted using modified congruence method. The trends in food demand to meet the food and nutritional security of people in 2015 and 2025 are projected. Research prioritization was attempted to meet the projected demand.

Trends in Food Demand

In South Asia, while cereals will continue to remain important constituents of the food basket, high-value foods such as fruits, vegetables, milk, meat, eggs and fish are rising in importance. Trends in food consumption pattern over the past two decades suggest changes in the composition of the food basket in stages from coarse grains to superior grains (rice and wheat), and from grains to livestock and horticultural products. This has significant implications for future food demand, research priority setting and resource allocation to achieve food and nutritional security. It is well realized that agricultural research should contribute to food and nutritional security and social empowerment of people in South Asia. In this task, the support and synergy with agri-services is no less important.

Tables 6.1 and 6.2 present the projected food demand and annual growth in South Asian countries for the years 2015 and 2025. It is evident that in 2025, food grain demand will be 339 million tons, comprising 147 million tons rice, 122 million tons wheat, 46 million tons coarse grains and 24 million tons pulses. By the year 2025, South Asia will need 13 million tons of roots and tubers (in dry equivalent), 17 million tons edible oils, 144 million tons vegetables, 103 million tons fruits, 47 million tons sweeteners, 205 million tons milk, 15 million tons meat, 4.8 million tons eggs, and 16 million tons fish to meet its domestic demand (assuming 3.5% growth in per capita income). High growth in livestock products' demand will put a pressure on food grains and oilcakes to meet the feed demand for livestock. Fast growth in income will diversify the dietary pattern in favour of non-foodgrain crops, livestock and fisheries products. As noted already, the per capita availability of arable land in South Asia is quite low and declining over time. Diversification towards these high-value

commodities, which are labour-intensive, can also provide adequate income and employment opportunities to the agricultural labourers and small farmers who dominate the agriculture in these countries. It is important to make significant efforts to increase yield per unit of inputs using science, by accelerating TFP as required yield targets would be quite challenging to attain the national food and household nutritional security in South Asia. Research priorities have to be worked out keeping in view the trends in demand. To sustain the demand shifts, commensurate developments in input supply, output marketing, processing, hard core infrastructure development, improvement in quality, ensuring safety, etc. are very critical.

To address such a big challenge, the goals, and objectives of the research system should change and the priorities identified should contribute to achieve those goals. Keeping these in view the prioritization methodology was selected and results are presented in Appendix 6.

Country and Commodity Priorities

With the objectives of increasing productivity (VOP), increasing in income of small farmers (poor), sustainable use of land and contributing more to exports, independently and collectively, the top 3 priority countries are: India, Pakisthan and Bangladesh (Table 6.4). The priority commodity groups in South Asia are found as cereals, horticulture, livestock and fishery and the priority commodities are rice and milk (Box 1, Tables 6.8, 6.9 and 6.10). In case of countries in the region, cereals top the priority list in Bangaldesh and Nepal, horticulture tops the priority list in India and Sri Lanka, and livestock in Pakistan. In the case of individual commodities, rice tops the list in Bangladesh, and Nepal, milk in India and Pakistan and plantation in Sri Lanka. The other important commodity/ies in different countries include rice in India, milk, meat and vegetables in Nepal, rice and edible oils in Sri Lanka and meat and wheat in Pakistan. By and large, these priorities will continue up to 2025, with slightly higher importance to horticulture, livestock and fishery in both South Asia region and all the countries in the region with the passage of time (2015, 2025). Shift in priority ratios during 2015 and 2025 by commodities in different countries and South Asia as a whole suggests augmentation of research resources towards vegetables, fruits,

Box 1

Commodity Priorities in South Asia

	Bangaldesh	**India**	**Nepal**	**Pakistan**	**Sri Lanka**	**South Asia**
Commodity priority	Rice	Milk Rice	Rice Milk Meat Vegetables	Milk Meat Wheat	Plantation Rice Vegetable oil	Rice Milk
Commodity group priority	Cereals Fishery Livestock Horticulture	Horticulture Cereals Livestock Fishery	Cereals Livestock Horticulture Fishery	Livestock Cereals Horticulture Fishery	Horticulture Cereals Livestock Fishery	Cereals Horticulture Livestock Fishery

milk, meat, eggs, and fish. These priorities need to be kept in view while deciding the research agenda and resource allocation and other needed agri-services development support.

Shift in Resource Allocation

An exercise was done to compare the existing resource allocations among commodity groups with the optimum level as per the identified priority scores.

The optimal and existing research allocations, presented in Box 2 and Table 6.13, reveal that in case of cereals, the existing research allocation is less than optimal in Bangladesh and more than optimal in India, Nepal and Pakistan. In case of horticulture, it is more than optimal in Bangaldesh, India, and Pakistan, whereas it is less than optimal in Nepal. In case of livestock, it is less than optimal in all South Asian countries, except Sri Lanka. In case of fishery, it is less than optimal in case of Bangaldesh, India, and Sri Lanka, whereas in case of Nepal and Pakistan, it is more than optimal. These results suggest the need to shift additional resources to Bangladesh for cereals, to Nepal for horticulture, to Bangladesh, India and Sri Lanka for fisheries and all the South Asian countries for livestock.

Box 2

Commodity-wise Allocation of Additional Resources

Country	Commodity
Bangladesh	Cereals
Nepal	Horticulture
Bangladesh, India and Sri Lanka	Fisheries
All South Asian Countries	Livestock

Research Prioritization with Focus on Poor

It is often observed that the current resource allocation is not in favour of poor. Hence, to assess how appropriate is the current allocation in relation to the needs of the poor, the case of India was analysed. The analysis showed that the priority index is the highest for very poor households (1.81), followed by poor (1.54), non-poor low income group (1.28) and

Box 3

Priority — the Poor

Category of Poor	Priority Index
Very poor	1.81
Poor	1.54
Non-poor Low income	1.28
Non-poor High income	0.69

non-poor high income (0.69) (Box 3, Table 6.14). For example, the results indicate that 81 percent additional income is required to the very poor households to meet the objectives of nutritional security and social empowerment and similarly for other categories.

Further, priority score of commodities by income groups for the years 2015 and 2025 revealed that the commodity priority must change with target groups (Table 6.15). For example, in case of cereals, priority score for all groups is 31, but in case of very poor category, it is 41 and in case of non-poor high income, it is only 24. Thus, it becomes very clear that the current resource allocation is not in favour of the poor. It can be seen that the very poor and poor together should receive more than 50% additional income to remain optimal towards nutritional security and social empowerment in terms of education, housing, transport, etc., which are the items of non-food expenditure. The additional income is to be generated through greater emphasis on livestock, horticulture, fisheries, and non-farm employment. Since the poor are the net buyers of food, their income has to be improved by (i) reducing the cost by increasing the knowledge input in place of purchased input, (ii) diversifying towards horticulture, livestock, fishery, and other rural non-farm enterprises, (iii) protecting well with safety net and income enhancement programmes, and (iv) strengthening agri-services and support system. The exercise has clearly established that in future, prioritization of research has to be made explicitly pro-poor, if it is the objective.

Augmentation of Research Resources to Make South Asia Food Secured

To attain the food security by meeting the projected demand during different years in future up to 2025, it is important to estimate the required investment in R&D in South Asian countries. The current (2002) level of R&D investment (at 2005 international dollar) is provided in Beintema and Stads, 2008. Using TFP information and the elasticity of research investment for raising output of all commodities, the investment required is projected at current growth rate of food supply at 2.4% per annum (existing) and target growth of 4% to meet the challenges of hunger and poverty in South Asia. If the current growth rate in food supply is to be maintained, the resource allocation has to be increased to 2390 million US dollars by 2020 from the current 1712 million USD in South Asia. If we target 4% growth rate, then it has to be raised to 3169 million USD (Tables 6.16 and 6.17). The 4% growth in agricultural GDP can only be attained with greater emphasis on the development of livestock, horticulture and fishery sectors. This will generate the additional income to the small and marginal farmers and reduce poverty and undernourishment and shall contribute to social empowerment. The results relating to required investment at current prices are indicated in Table 6.18. Thus investment has to be nearly doubled at constant prices and tripled at current prices. It is observed (Bientema and Stads, 2008) that sustainable financial and political support for agricultural R&D is crucial, as is the creation of attractive investment climates for private investors, if the challenges of sustainable economic and social development facing the region are to be met.

3.2.2. The results of research prioritization done earlier by others relating to South Asian countries are provided in Appendices 2, 3 and 4. They were also made use of in the final proposal under sub-section 3.2.5.

3.2.3. The sub-regional e-consultation

The e-consultation in the sub-region along with other sub-regions in the AP region was organized during September 4 to 21, 2009. Formal letters of invitation with detailed instructions, key issues to be considered for response and the main questions for facilitating the consultation were shared with the participants representing all the stakeholders. The responses were received in stages during the period of e-consultation and there was a lively exchange of thoughts and opinions which have sharpened the responses. Finally, responses were received from 124 participants in South Asia out of about 200 contacted. The responses in the form of suggestions related to cost effectiveness of research, policy issues, institutional arrangements, improvements in farmers' income, bridging the yield gaps, sharing of innovations, following the value chain, reforms in education and research, enhancing the competitiveness of farmers, reaching the farmers with up-to-date useful information, etc. The specific suggestions which are important, novel and voiced by many are appropriately reflected under section 3.4 of the Report.

3.2.4. The key areas of agricultural research being proposed on the basis of review, analysis done in this exercise as discussed above are presented below under two heads:

Commodity Priorities

- Rice
- Milk

Commodity/Group Priorities

- Cereals
- Horticulture
- Livestock
- Fishery

3.2.5. The key over-arching areas of agricultural research for development proposed as per the literature review and suggestions from e-consultation are:

Over-arching Priorities

- Natural resource management
- Human resource development
- Socio-economics and policy research
- Germplasm collection, conservation and improvement
- Strengthening of NARS institutions
- Strengthening of basic and strategic research in the frontiers areas of agricultural sciences

3.2.6. The key areas that requires specific investments as per the recommendations of F2F meeting include:

(a) Farming systems approach in ecosystem framework to pursue diversification (livestock, horticulture, fisheries)

(b) Focus on women and youth in agricultural research
(c) Inclusion of local crops, along with wheat, rice and pulses as priorities
(d) Involve progressive successful farmers, NGOs and private entrepreneurs in technology transfer
(e) Address impact of climate change on agricultural production
(f) Develop contingent plan for natural calamities
(g) Focus on post-harvest management, value addition, quality improvement and safety,
(h) Improve risk management capacity by suitable farmer friendly policies, programmes and business models
(i) Linking farmers with market through value chain approach
(j) Policy dialogue with effective communication
(k) Blending modern technologies, innovations with proven indigenous technologies
(l) Exploring income and employment opportunities beyond agriculture in rural areas

3.3. Main Development Barriers Constraining Escape from Poverty

The main development barriers constraining the escape from poverty include the following:

- Lack of adequate investment in agriculture in general and agricultural R&D in particular
- Lack of adequate trained manpower, prevalence of illiteracy and lack of /low skills of farmers
- Unfavourable support institutions and policies
- Undependable and inadequate supplies, services and support systems
- Highly inequitable growth within and among the South Asian counties
- Frequent and intensive natural disasters like droughts and floods
- Increasing security threats owing to conflicts and violence within and among South Asian countries seriously disturbing development efforts
- Ineffective and corrupt governance
- Lack of political will and commitment
- Poor infrastructure like roads, communications, power supply, health, education, etc.
- Inadequate research and extension, credit, and market
- Poor management of income improvement and safety net programmes

3.4. Forms of New Knowledge, Capacities and Skills Required to Address the Development Barriers

The new knowledge, capacities and skills are listed under funding, research, extension, education and training, and socio-economics and policy. It is important to recognize that these new knowledge, capacities and skills can contribute to improved livelihoods of poor only when complimented with adequate and effective investment in providing agro-services combined with able governance and commitment mostly by the governments of these countries. But, involvement of private sector in PPP modes in each investment will be more sustainable in the long-run as can be seen from the success stories in these countries. The

lessons learnt in such PPP success stories suggest that the dialogue on PPP roles in agricultural R&D has to move beyond partnership since clear domains of comparative advantage (e.g. seed, agro-chemicals, farm equipments and machinery) are emerging and public systems need to respond to it (Jha and Kumar, 2006)

Funding

- Emerging challenges in climate change adaptation, water scarcity, soil fertility and bio-diversity erosion, institutional and human resources development, biotic stresses and bio-security call for greater resource allocations and their effective utilization. Most of the NARS do not have capacity to conduct research on these areas owing to lack of trained manpower and facilities.
- Research grants should be linked to involvement of stakeholders in defining the research agenda and clear identification of the nature of beneficiary of research.
- There needs to be a better balance between (a) long-term funding, to ensure continuity and the ability to undertake long-term research, and (b) competitive short-term funding to allow fast response to the emerging research challenges and to ensure quality and relevance.
- Donor agencies must be willing to fund the more downstream efforts of R&D institutions.

Research

- Develop a systematic and consultative process of identification of research agenda. Still resource allocation to non-commodity research (e.g. NRM, socio economic and policy, gender analysis, etc.) is not based on systematic prioritization exercises. This needs attention. Similarly, there is an incorrect perception that investment in research and investment in agro-services are two independent distinct activities. Both are important and needed for maximum impact.
- The status of natural resources – land (soil), water and biodiversity — has to be systematically assessed and good management practices need be developed.
- Develop less external input using but high return farm practices.
- Research strategy has to move from knowledge generation to innovations by involving all major stakeholders, namely, farmers, agro-industry, CSOs and market players
- AR4D models should be duly verified through formal participatory research and extension teams under real farming situations and based on merit should be scaled up and scaled out.
- In case of bio-technology and organic agriculture, science has to establish truths after demystifying several existing myths. If there are economic, nutritional and biosecurity niches for profitable organic production (green agriculture), it has to be vigorously promoted. Similarly, where farmer-friendly agro-techniques generated through the use of biotechnology have a proven advantage and science is clear about their impact on farmers' livelihoods, human health, biodiversity and environment, not allowing farmers to access such technologies is difficult to justify.

- Diversification should commensurate with income, nutrition, soil and water availability and their conservation, employment opportunity, equity, market trend and access, technology, labour and energy availability with research effort broadened to a range of crops and commodities, including coarse grains, legumes, roots and tubers, fruits and vegetables, livestock, aquaculture and agroforestry (to benefit specifically women).

Extension

- Involve leading innovative small farmers as champion change agents since the current extension machinery is defunct. The successful farmers should serve as resource persons to guide the research and scale-up programs in a "farmer-to-farmer" module.
- Successful farmers should lead/guide the extension system and there should be greater respect for farmer as the practitioner and for the professional knowledge of farmers (both men and women).
- Extension/technology/knowledge transfer systems must be revitalized and strengthened and rendered more relevant, dynamic, farmer-centric and development oriented. Common weaknesses include: (i) lack of connection between teaching, research and extension institutions and agencies in many countries, (ii) lack of cooperation between government, NGOs and private sectors, (iii) lack of integrated approaches along the whole value chain, and (iv) lack of up-to-date knowledge of extension staff in new areas like livestock, fisheries, NRM, market, prices, etc.
- The recent developments in ICT, village knowledge centres, TV and radio networks should be used for sharing knowledge and information and to link extension centers to markets – a market-led extension. Several studies have revealed the efficacy of mobile phones in message sharing, particularly for market-related information.
- Farm schools established at the farms of lead farmers have proved to be highly effective for farmer-to-farmer extension, particularly of complex messages and technologes such as those related to integrated farming, integrated pest management, integrated plant nutrient management, integrated crop care, etc. The approach should thus be vigorously promoted.

Education and Training

- Most of the NARS do not possess "soft skills" such as research planning, priority setting, impact assessment, innovative resource mobilization, documentations, communications, etc. These skills need to be imparted and made use of for planning and monitoring the programmes.
- Risks, accountability and benefits of research must be clearly defined and results recorded and shared. Innovative and progressive farmers should be trained to record data and maintain documentation so that their experiment, experience and learning are available to the agricultural scientists, professionals and other farmers. Where this is not possible due to educational literacy issues, a research assistant may be attached part time with specific responsibility.

- Efforts should be undertaken to provide basic systematic agricultural knowledge to a much wider audience, preferably all stakeholders — farmers, traders, exporters, input dealers etc. Ideally, this could be achieved through collaborating with educational institutions to develop agricultural modules for rural primary and secondary schools and agriculture should be made a compulsory subject in all schools. College/University curricula should also include the traditional integrated agriculture systems and should have desired infrastructure/labs and competitive salary/service structure.
- Since the job-market determines inflow of students in a given discipline, it is imperative that course designing shall be an ongoing marketing strategy of universities. Developing areas such as intellectual property management, molecular technology, technology adoption, marketability of knowledge and products are to be cared for curriculum changes and teaching/training.

Socioeconomics and Policy

- Researchers need to work more closely with development agencies and policymakers so that appropriate action research is planned and pursued for small and marginal farmers, landless farmers, pastorals, small fishers and tribals.
- The NARS and policy action bodies should be restructured appropriately to integrate research disciplines on human, animal and crop health in such ways that there is homology of research concepts to attain homeostasis in villages.
- Policy research should be undertaken to evolve suitable options on: (i) climate change impact for different agro-climatic zones and adaptation/mitigation strategies, (ii) pricing, subsidy and marketing for agricultural inputs and outputs to ensure equitable return to farmers and affordable prices for consumers, (iii) agricultural terms of trade to provide incentive for on-farm investments by ensuring minimum guaranteed price to farmers in the event of market failures, and (iv) strategic interventions in the market to ensure affordable price to consumers for all major food commodities.
- Farmers must be linked with markets and enabled to capture most of the price paid by the consumer through promoting Producer Companies, small farmers' estates, cooperatives and SHGs. Farmers should be partners all along the producer-consumer value chain through "Producer Company" approach. Efficacy of these systems should be researched to provide effective guidance for their adoption.
- Strengthen rural agro-processing and post-harvest management of field crops, horticultural crops, livestock, fishery and generate employment by promoting other rural enterprises involving value/supply chain of agri-products.
- Outdated legal and regulatory frameworks often hinder introduction and adoption of modern technologies. Reform or rationalize them.
- Rising capital intensity, particularly in the high-growth sectors of agriculture, has set in motion a new set of forces leading to biased knowledge, technological and market

developments and thus exacerbating the problems of poor and small farmers. Declining growth in public investments and eroding institutional infrastructure are other disturbing features of the current trend. These need to be studied and corrective actions taken.

- Market-driven diversification in a global perspective has become the new paradigm driving future agricultural growth. The most profound shift pertains to rapid privatization in all domains — production, consumption, investment, technology, etc. and concomitant decline in State control. This trend has generally excluded the marginal farmers and dampened their enthusiasm to adopt new technologies. The role of the State should be redefined as public goods, welfare imperatives, other regulatory needs, and market failures continuously need government intervention with focus on resource-poor farmers.
- New policy is needed for handling agricultural commodities (both perishable and non-perishable) on an order-based production mode (a type of contract farming; Minimum Support Price does not ensure such contract), wherein governments should secure public interest. The worthiness of a suitable design shall be through both backward and forward linkages.
- Research institutions are quite willing to be development friendly and even entrepreneurial, but when demands for impact and profit come in unrealistically short-time frames which do not suit agricultural research and development activities, then neither the donors nor the R&D institutions will be satisfied by their performance. Resolving this issue is important.
- Competitiveness of farmers in developing countries is adversely affected by non-tariff barriers in the globalised world. Increased emphasis is required on biosecurity, gene literacy and food and health safety at all levels, especially at the grassroot level. Research is needed for undertaking comprehensive risk analysis and management along the value chain. Inter-country cooperation in research and surveillance, monitoring and control for managing trans-boundary diseases and pests should be strengthened. Monetary benefits should be provided to farmers practising various safety measures and adopting Good Agricultural Practices. Advocacy to ensure biosecurity by decision-makers is the most pressing need.
- Safety standards and regulations are to be the domain of enforcing system that guide the agriculturists and relevant stakeholders about the global demands and national interest about these issues. Grassroot-level literacy and awareness on these aspects can build up only when volumes of market-driven production find place in villages.
- Unfortunately, the research community is not very effective in communicating with policy makers and ensuring that information and knowledge is delivered to the right people at the right time in the right format. There is a need to a) better understand the processes leading to agricultural development policies and the contribution provided by research outputs, b) undertake research on how to strengthen the research-policy-practice interfaces to increase the impact of research outputs, and c) train researchers on how to communicate better and interact with policy makers.

Chapter 4

Fit between Recommendations and Implementation

The gaps and scale issues that are important to be noted in the case of South Asian countries include the following:

The NARS in South Asian countries are at different stages of evolution. For example, they are non-existent or at a preliminary stage in Maldives, Bhutan, and Afghanistan. Though they are existing in Nepal, Bangladesh, Pakistan and India, there is lot of scope to re-orient them to address the emerging complex agenda and challenges. UNU-MERIT (2008) presented a typology of innovation capacity in the region to target the capacity strengthening. It is provided in Box 4. As the information in Box suggests, some countries have well-developed scientific capacity (e.g. India) and others have well-developed institutional (e.g. Bangladesh for strong Civil Society organizations and Pakistan for private sector linkage) and policy (e.g. India) arrangements. Based on the review of development challenges, current strengths, aspirations expressed through e-consultation, the following major gaps emerge:

Box 4

Patterns of innovation capacity development in South Asia

Institutional and Policy change →

Agricultrural Science Capacity ↑

Transition from scientific capacity orientation Pakistan Sri Lanka	**Towards a responsive adaptive innovation architecture** India
Recovery from conflict Nepal Afghanistan	**Transition from social capacity orientation** Bangaldesh

Source: UNU-Merit (2008)

1. Investment in agricultural R&D has to be at least one percent of agricultural GDP in these countries. The level of current investment has to be tripled in the next 5 to 10 years. Global research support to these countries should also increase at this scale.
2. Trained human resource has to be increased in both quality and quantity to manage agricultural research, education and extension systems in particular and agriculture in general in these countries. Training of scientists in a big way in frontier areas of science and soft skills in Centre of Advanced Studies, locally, regionally and globally is necessary.
3. Action research pursuing value-chain approach for providing end-to-end solutions in agricultural produce and sustainable rural livelihood security of poor located in disadvantaged areas, packaging proven technologies innovations (indigenous blended with modern) with supportive institutional and policy innovations.
4. Issues relating to use of modern technologies like biotechnology, organic farming get unduly debated, mostly on perceptions and opinions. Scientific truths have to be established and should guide policymaking and public opinion.
5. Strengthening research in NRM, climate change, and socio-economics and policy research. Capacity building in these areas should get priority attention.
6. Linking farmers or their organizations with research, extension and markets
7. Strengthening post-harvest management, agro-processing, quality safety, biosecurity, risk analysis systems
8. Augmenting foodsafety nets and income augmenting programmes located in disadvantaged areas to the vulnerable
9. Negotiating the policy space to meet the objectives of food security of poor in the WTO regime
10. Creation of multiple livelihood opportunities, including rural non-farm employment opportunities
11. Strengthening of data and information systems for proper development planning
12. Political will, commitment and effective governance by the Governments is an uncertainty.
13. Enhancing regional co-operation in food reserve management, transboundary disease management, exchange of germplasm and success stories in agricultural research for development, training and capacity building, catalyzing the SAFTA for promoting intra-regional agricultural trade.

Chapter 5

Concluding Summary

The main conclusions of the review and e-consultation include:

1. There is generally a similarity of agricultural development situations and issues in South Asian countries, though their nature and extent vary.
2. The major challenges before the countries in the South Asian region include extreme poverty, hunger, illiteracy, falling agricultural productivity, low investment in agriculture in general and agricultural research in particular, almost defunct extension system, unfavourable policies, weak institutions, poor service and support system, ineffective governance, poor service and support system, lack of political will and commitment, rising conflicts, failure of regional co-operation, etc.
3. The drivers of development for the South Asian region are well defined and a general consensus exists on these drivers broadly such as reducing poverty, addressing sustainability of natural resources, promoting exports, increasing agricultural productivity, strengthening agricultural research systems, etc.
4. Agricultural research prioritization is attempted mostly through collective judgement, but in India and Pakistan, formal but simple prioritization exercises are done and being referred to for planning investment. APAARI is guiding this process in these countries. One of the reasons for not attempting vigorous prioritization exercise is lack of required data and information.
5. There is a general agreement that the research systems need to involve all the stakeholders and re-orient their research agenda particularly to target poor, small and marginal farmers, involve in the implementation in collaboration with private sector, NGOs, government departments, CSOs, etc.
6. Across countries, knowledge management is very weak under-resourced and outdated in relation to complex emerging challenges like climate change, natural resource management, serving sunrise sectors like livestock, fishery, agro-forestry, disseminating market intelligence, weather advisory, etc.
7. The priorities for resource allocation across the countries generally include cereals, horticulture, livestock, fishery and forestry and the commodities which require greater resources include rice and milk (livestock). The other non-commodity priority areas include natural resource management, human resource development, training and skill development of all stakeholders, socio-economics and policy research, germplasm collection, conservation and improvement, strengthening NARS institutions and strengthening basic and strategic research in the frontier agricultural science areas
8. Certain new approaches to do business differently are required such as following farming systems approach in ecosystem framework, participatory research involving farmers,

women, youth and vulnerable groups, value chains, blending traditional knowledge with modern technologies, community based management of resources, public-private sector partnership, linking farmers with markets, etc.

9. The resource allocation has to be targeted to poor which is not attended now.
10. To address priority areas with additional resources, research resources have to be tripled in relation to the existing allocation in these countries when 4% growth in agricultural GDP is possible. It may be noted that 4% growth in agricultural GDP can only be attained with greater emphasis on the development of livestock, horticulture and fishery sectors.

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Appendix 1

South Asia: Socio-Economic Setting

Economic Performance Impressive but Needs Acceleration and Inclusiveness

The economic performance measured in terms of annual growth (%) in per capita GDP during 1990-2005 indicates impressive performance of South Asian countries (3.4%) as compared to the world (1.5%). It was above 3% in all South Asian countries except Nepal and Pakistan, where it was 2% and 1.3%, respectively (Table 1.1). It is important to note that value-added percentage of GDP is decreasing considerably in agriculture across all countries and that of industry and particularly of service sector, has improved substantially (Table 1.2). This is a significant positive trend seen during development, but what is disturbing is the continued dependence of people on agriculture (Table 1.3). This directly results in lower per worker productivity in agriculture, level of competitiveness, profitability, etc. besides other problems in rural areas. There is a need to establish agro-industries (food processing, etc.) where the surplus manpower from agriculture can be shifted for gainful employment. The growth in labour productivity in agro-industry is very impressive, 2-6% (Table 1.4).

Unacceptable Level of Poverty and Malnutrition in South Asian Region

Poverty is rampant in the region. Nearly one-third of the population lives below national poverty line though it is as much as 50% in Bangaldesh (Table 1.5). In fact, rural poverty is

Table 1.1: Economic performance in South Asia and World

Country/ Region	GDP per capita (PPP US $)	Annual growth (%) per capita GDP		Annual change in consumer price index	
Year→	2005	1975-05	1990-2005	1990-2005	2004-05
Bangladesh	2053	2	2.9	5.1	7
Bhutan		5.4	5.6	7	5.3
India	3452	3.4	4.2	7.2	4.2
Maldives			3.8	4.3	3.3
Nepal	1550	2	2	6.8	6.8
Pakistan	2370	2.5	1.3	7.5	9.1
Sri Lanka	4595	3.2	3.7	9.5	11.6
South Asia	3416	2.6	3.4		
Developing countries	5282	2.5	3.1		
World	9543	1.4	1.5		

Source: Human Development Report 2007/2008, United Nations

Table 1.2: Economic indicators

Country/ Region	Annual GDP growth (%)		Per capita GDP growth (%)	Value added as % of GDP			
				Agriculture		Industry	Service
	1990-99	2000-06	2005-06	1999	2006	2006	2006
Afghanistan				36	24	39	110
Bangladesh	4.8	5.6	4.8	21	20	28	52
India	6.1	7.4	7.7	28	18	28	55
Nepal	4.8	3.3	0.8	41	34	16	49
Pakistan	4.0	5.5	4.8	26	19	27	53
Sri Lanka	5.3	4.8	6.2	21	16	27	56
South Asia		7.0	7.0		18	28	54
World		3.0	2.6		3	28	69

Source: Human Development Report (2007-2008), United Nations

Table 1.3: Dependence on agriculture for output and employment

Country/ region	Share in GDP (%)		Share in workforce (%)		Ratio of per worker income in non-agri to agri-sector	
	1990	2005	1990	2005[#]	1990	2005
Afghanistan		39.5		69.6		3.5
Bangladesh	29.4	21.0	61.6	51.7	3.9	4.0
Bhutan	—	22.4		—		
India	29.3	18.3	64.0	54.4	4.3	5.3
Maldives	—	2.6		3.0		1.2
Nepal	50.6	38.2	—	76.0	—	5.1
Pakistan	26.0	21.5	51.2	43.0	3.0	2.8
Sri Lanka	22.9	17.3	46.8	30.7	3.0	2.1

[#]Data for Bangladesh refer to year 2003, and for Cambodia 2004
Source: adb.org database

higher than urban poverty. Similarly nutritional status is dismal. The proportion of undernourished in total population is nearly 1/5th and it is as much as 230 million in India out of 314 million in South Asia (Table 1.6).

The Record of Human Development

The record of South Asian countries in human development is much desired. Sri Lanka and Maldives are the countries whose ranks are the highest in the region (99 and 200,

Table 1.4: Labour productivity in agro-industry in India

Industry	Productivity/worker (INR at 1981-82 prices)			Annual growth rate (%)	
	1984-85	1994-95	2000-01	1984-85/1994-95	1994-952000-01
Unorganised Agro-manufacturing					
Food Processing	2628	2611	3248	-0.07	3.71
Other Agro-based	2408	2902	4208	1.88	6.39
Total Agro-based	2479	2789	3858	1.18	5.56
Total Non-agrobased	4455	5257	6979	1.67	4.83
All Industries	2961	3660	4615	2.14	3.94
Organised Agro-manufacturing					
Food Processing	15500	25771	33031	5.20	4.20
Other Agro-based	16800	35814	40913	7.90	2.20
Total Agro-based	16306	31099	37373	6.70	3.10
Total Non-agrobased	35669	71432	97612	7.20	5.30
All Industries	26134	51656	66703	7.10	4.40

Source: Joshi *et al.* (2007)

Table 1.5: Percentage of total population below national poverty line in South Asia

(in per cent)

Country	Bangladesh	India	Nepal	Pakistan	Sri Lanka
Survey Year	1995	1993	1995	1993	1995
Rural	55.2	37.3	43.3	33.4	27.0
Urban	29.4	32.4	21.6	17.2	15.0
National	51.0	36.0	41.8	28.6	25.0
Survey Year	2000	1999	2003	1998	2002
Rural	53	30.2	34.6	35.9	7.9
Urban	36.6	24.7	9.6	24.2	24.7
National	49.8	28.6	30.9	32.6	22.7
Annual change in poor, %					
Rural	-0.8	-3.5	-2.8	1.5	-16.1
Urban	4.5	-4.4	-9.6	7.1	7.4
National	-0.5	-3.8	-3.7	2.7	-1.4

Source: FAO data

respectively), but are much below even among some other developing countries. The life expectation index, education index and GDP index closely follow the human development index and these countries have to make sincere efforts soon to improve these indices (Table 1.7), though they are improving it slowly over the years (Table 3).

Table 1.6: Nutritional status in South Asia, the Pacific and World: 1990-2005

Country	Proportion of undernourished in total population (%)			Number of people undernourished (million)		
Survey year	1990-92	1995-97	2003-05	1990-92	1995-97	2003-05
Bangladesh	36	40	27	41.6	51.4	40.1
India	24	21	21	206.6	199.9	230.5
Nepal	21	24	15	4.0	5.3	4.0
Pakistan	22	18	23	25.7	23.7	35.0
Sri Lanka	27	24	21	4.6	4.4	4.0
South Asia	25	22	21	282.5	284.8	313.6
The Pacific	20	17	16	582.4	535.0	541.9
World	16	14	13	841.9	831.8	848.0

Source: FAO data

Table 1.7: Human Development Index (HDI) in South Asia: 2005

Country/ Region	Human Development Index (HDI)		Life Expectation Index	Education Index	GDP Index
	Rank	Index			
Bangladesh	140	0.547	0.635	0.503	0.504
Bhutan	133	0.579	0.662	0.485	0.589
India	126	0.619	0.645	0.620	0.591
Maldives	100	0.741	0.701	0.862	0.661
Nepal	142	0.534	0.626	0.518	0.458
Pakistan	136	0.550	0.637	0.493	0.519
Sri Lanka	99	0.743	0.776	0.814	0.639
South Asia		0.611	0.646	0.598	0.589
Developing countries		0.691	0.685	0.726	0.662
World		0.743	0.718	0.750	0.761

Source: Human Development Report (2007-2008), United Nations

Literacy — A Major Deterrent for Growth

Adult literacy rate is substantially lower in South Asia (59.7%) as compared to world (82%), except in Maldives where it is even higher than the world average (96%). The position is highly dismal in Bangladesh, Nepal and Pakistan (47-49%). India also has to improve literacy level for accelerating technology uptake. It is satisfying to note that youth literacy rate is better in every country, which offers some hope of better growth (Table 1.9).

Table 1.8: Trends in Human Development Index in South Asia: 1975-2005

Country	1975	1985	1995	2005	Increase, % (1975-2005)
Bangladesh	0.347	0.392	0.453	0.547	57.6
Bhutan				0.583	
India	0.419	0.487	0.551	0.619	47.7
Maldives				0.741	
Nepal	0.301	0.380	0.469	0.534	77.4
Pakistan	0.367	0.427	0.497	0.551	50.1
Sri Lanka	0.619	0.683	0.721	0.743	20.0

Source: Human Development Report (2007-2008), United Nations

Table 1.9: Literacy rate in South Asia and World: 1985-2005

Country/ Region	Adult literacy rate, % (aged 15 and older)		Youth literacy rate, % (aged 15-24)		Children reaching age 5,% (grade 1 students)	
Year®	1985-94	1995-2005	1985-94	1995-2005	1991	2004
Bangladesh	35.3	47.5	44.7	63.6		70
Bhutan						
India	48.2	61	61	76.4		89
Maldives	96	96.3	98.2	98.2		92
Nepal	33	48.6	49.6	70.1		65
Pakistan		49.9		65.1		91
Sri Lanka		90.7		95.6		92
South Asia	47.6	59.7	60.7	74.7	51	61
Developing countries	68.2	77.1	80.2	85.6		
World	76.4	82.4	83.5	86.5		

Source: Human Development Report (2007-2008), United Nations

Asian Children (Future of Asia) are under Threat

The percentage of underweight children under 5 years of age is as high as 47-48% in India, Bangladesh and Nepal and the percentage is slightly higher in these countries even for under-height children. Of one out of every 3-4 infants born, weight will be below recommended level (Table 1.10). Similarly, the infant mortality rate is also high, though it is slowly declining over the years (Table 1.11). There is a wide variation in the availability of health resources and access to doctors among the countries of the region. For example, the

Table 1.10: Percentage of under-weight, under-height children and of under-weight infants in South Asia

Country/ Region	Children under 5 years, % (1996-2005)		Infants with birth under weight, % (1998-2005)
	Underweight	Underheight	
Bangladesh	48	51	36
Bhutan	19	48	15
India	47	51	30
Maldives	30	32	22
Nepal	48	57	21
Pakistan	38	42	19
Sri Lanka	29	18	22

Source: Human Development Report (2007-2008), United Nations

Table 1.11: Infant mortality in South Asia and World: 1970-2005

Country/ Region	Infant mortality rate (per 1000 live birth)			Under-five mortality rate (per 1000 live births)		
	1970-75	2000-2005	Change per annum, %	1970-75	2000-05	Change per annum, %
Bangladesh	145	54	-3.2	239	73	-3.9
Bhutan	156	65	-2.9	267	75	-4.1
India	127	56	-2.7	202	74	-3.3
Maldives	157	33	-5.1	255	42	-5.8
Nepal	165	56	-3.5	250	74	-4.0
Pakistan	120	79	-1.4	181	99	-2.0
Sri Lanka	65	12	-5.5	100	14	-6.3
South Asia	130	60	-2.5	206	80	-3.1
Developing countries	109	57	-2.1	167	83	-2.3
World	96	52	-2.0	148	76	-2.2

Source: Human Development Report (2007-2008), United Nations

per capita health expenditure in US$ is 494 in Maldives as compared to only US$ 48 in Pakistan and US$ 91 in India. Similarly, the number of physicians per lakh population is 92 in Madives as compared to only 5 in Bhutan (Table 1.12).

Table 1.12: Health resources and access service in South Asia: 2004

Country/ Region	Health expenditure		Per capita (PPP US $)	Physicians per 100000 people
	Public % of GDP	Private % of DGP		
Bangladesh	0.9	2.2	64	26
Bhutan	3	1.6	93	5
India	0.9	4.1	91	60
Maldives	6.3	1.4	494	92
Nepal	1.5	4.1	71	21
Pakistan	0.4	1.8	48	74
Sri Lanka	2	2.3	163	55

Source: Human Development Report (2007-2008), United Nations

Demographic Transition

South Asia witnessed higher than average world growth in population during 1975-2005. It was 2.1% in South Asia as compared to 1.6% in the world. It was above 2% in all the countries of the region, except in Sri Lanka, where it was 1.10% and maximum growth rate was observed in Pakistan (2.8%) (Table 1.13). Urbanization is also proceeding fast and

Table 1.13: Demographic trends in South Asia and World: 1975-2015

Country/Region	Total population (million)			Annual population growth rate	
	1975	2005	2015	1975-2005	2005-2015
Bangladesh	79.0	153.3	180.1	2.2	1.6
Bhutan	0.4	0.6	0.7	1.9	1.5
India	613.7	1134.4	1302.5	2.0	1.4
Maldives	0.1	0.3	0.4	2.6	1.8
Nepal	13.5	27.1	32.8	2.3	1.9
Pakistan	68.3	158.1	190.7	2.8	1.9
Sri Lanka	13.7	19.1	20.0	1.1	0.4
South Asia	835.4	1587.4	1842.2	2.1	1.5
Developing countries	2972.0	5215.0	5957.0	1.9	1.3
World	4076.0	6514.0	7295.1	1.6	1.1

Source: Human Development Report (2007-2008), United Nations

South Asia recorded urbanization of 1.78% during 1975-2005 as against 1.36% in the world. Maximum urbanization growth was in Nepal (6.14%) and slightly negative growth in Sri Lanka (-0.27%) (Table 1.14). Yet another feature of demographic changes includes younger population forming 34% of the total population in 2005 in South Asia as against 26.3% in the world (Table 1.15). One of the fall outs of increasing population and urbanization is their adverse effect on sanitation and finally on the health of people. For example, the population using improved sanitation was just 37% in South Asia during 2004 as compared to 59% in the world. The position of India is the lowest in this aspect (33%), even less than South Asia average (Table 1.16)

Table 1.14: Urbanization in South Asia and World: 1975-2015

Country/Region	Urban population (% of total)			Annual growth in urbanization	
	1975	2005	2015	1975-2005	2005-2015
Bangladesh	9.9	25.1	29.90	4.76	1.77
Bhutan	4.6	11.1	14.80	4.50	2.92
India	21.3	28.7	32.00	1.50	1.09
Maldives	17.3	29.6	34.80	2.72	1.63
Nepal	4.8	15.8	20.90	6.14	2.84
Pakistan	26.3	34.9	39.60	1.42	1.27
Sri Lanka	19.5	15.1	15.70	-1.27	0.39
South Asia	21.2	30.2	33.80	1.78	1.13
Developing countries	26.5	42.7	47.90	2.41	1.16
World	37.2	48.7	52.80	1.36	0.81

Source: Human Development Report (2007-2008), United Nations

Table 1.15: Population dynamics by age group in South Asia and World

Country/Region	Population under age 15 (% of total)		Population aged 15-65 (% of total)		Population aged 65 and older (% of total)	
Year→	2005	2015	2005	2015	2005	2015
Bangladesh	35.2	31.1	61.3	64.6	3.5	4.3
Bhutan	33.0	24.9	62.4	69.7	4.6	5.4
India	33.0	28.7	62.0	65.5	5.0	5.8
Maldives	34.0	29.0	62.2	67.1	3.8	3.9
Nepal	39.0	34.1	57.3	61.7	3.7	4.2
Pakistan	37.2	32.1	58.9	63.6	3.9	4.3
Sri Lanka	24.2	21.4	69.3	69.3	6.5	9.3
South Asia	33.6	29.5	61.7	65.1	4.7	5.4
Developing countries	30.9	28.0	63.6	65.6	5.5	6.4
World	26.3	26.0	66.4	65.7	7.3	8.3

Source: Human Development Report (2007-2008), United Nations

Table 1.16: Water and sanitation in South Asia and World: 1990-2004

Country/Region	Population using an improved water source, %		Population using improved sanitation, %	
Year→	1990	2004	1990	2004
Bangladesh	72	74	20	39
Bhutan		62		70
India	70	86	14	33
Maldives	96	83		59
Nepal	70	90	11	35
Pakistan	83	91	37	59
Sri Lanka	68	79	69	91
South Asia	72	85	18	37
Developing countries	71	79	33	49
World	78	83	49	59

Source: Human Development Report (2007-2008), United Nations

Employment to People: A Major Source of Growth

Unemployment is a national problem resulting in wastage of output/talent. Providing gainful employment through creation of employment opportunities as well as upgradation of the skills should receive greater attention. The unemployment rate is significant in these countries, it varied between 1.8% in Nepal and 7.7% in Pakistan and Sri Lanka (Table 1.17). One of the adverse effects of unemployment is the increased social conflict, insurgency, etc. in these countries.

Table 1.17: Unemployment in formal sector in South Asia

Country/ Region	Unemployed People (Thousand) 1996-2005	Total (% of labour force) 1996-2005	Female (% of male rate) 1996-2005
Bangladesh	2002	4.3	117
India	16634	4.3	100
Maldives	2		
Nepal	178	1.8	85
Pakistan	3566	7.7	194
Sri Lanka	623	7.7	216

Source: Human Development Report (2007-2008), United Nations

Availability of Electricity — An Indicator of Development

Rural energy has become a major issue for rural development. The annual growth in primary energy during 1990-2005 was about 4% in South Asia as compared to 1.8% in the

world. The status of annual growth of primary energy supply indicates wide variations among countries and in Nepal it fell by 20% during 1999-2005. Thus, emphasis has to be accorded to management of renewable energy sources like solar, wind, biomass and agro-wastes, etc. (Table 1.18).

Table 1.18: Energy sources in South Asia and World

Country/ Region	Total primary energy supply (MT of oil equivalent)		Annual growth (%)	Share of total primary energy supply					
				Fossil fuels, 2005			Renewable energy		
				Coal	Oil	Natural gas	Hydro-solar & wind	Biomass & waste	Other nuclear
Year→	1990	2005							
Bangladesh	12.8	24.2	4.3	1.4	19.2	44.7	0.5	34.3	0
India	319.9	537.3	3.5	38.7	23	5.4	1.7	29.4	0.8
Nepal	5.8	0.2	-20.1	2	9.2	0	2.3	86.6	0
Pakistan	43.4	76.3	3.8	5.3	21.9	33.4	3.5	35.5	0.8
Sri Lanka	5.5	9.4	3.6	0.7	43.2	0	3.2	52.9	0
South Asia	456.2	818.9	4.0	26.1	28.3	17.9	1.7	25.3	0.6
World	8757.7	11433.9	1.8	25.3	35	20.7	2.6	10.1	6.3

Source: Human Development Report (2007-2008), United Nations

Forests to Serve as Sinks for Carbon Emission

Forests are to be maintained and developed to serve the mankind for sustainable supply of ecosystem services. The countries in the South Asia fall short (14.2%) of world average (30.3%) and countries like Maldives, Pakistan, Bangaldesh have to give priority attention to creation of this wealth (Table 1.19). The average per capita CO_2 emission is very high at the world level (4.5%) (Table 1.20).

Communication for Development

Information technology is revolutionalising the growth process everywhere. Modern ICTs are used for better connectivity, information, technology transfer and better decision-making. The ICTs have a greater role to play in technology dissemination in agriculture. As can be seen in Table 1.21, the number of telephone lines per thousand people has increased in all the countries, particularly in Sri Lanka and Maldives. Similarly, the numbers of cellular phone subscribers and internet users per thousand people are increasing. In one of the recent studies to find answers to the use and impact of mobile phones and mobile-enabled service on agricultural productivity (Sanjay *et al.,* 2009), it is shown that although, mobile phones can act as catalyst in improving farm productivity and rural incomes, the quality of

Table 1.19: Forest land status in South Asia and World

Country/Region	% of total forest land area 2005	Average annual change in forest area (%) 1990-2005
Bangladesh	6.7	-0.1
Bhutan	68	0.4
India	22.8	0.4
Maldives	3	0
Nepal	25.4	-1.6
Pakistan	2.5	-1.6
Sri Lanka	29.9	-1.2
South Asia	14.2	0.1
Developing countries	27.9	-0.4
World	30.3	-0.2

Source: Human Development Report (2007-2008), United Nations

Table 1.20: Carbon dioxide emissions and stocks in South Asia and World

Country/Region	Total (Mt CO_2)		Annual change, %	Share of world total, %		Per capita CO_2 (t CO_2)	
	1990	2004		1990	2004	1990	2004
Bangladesh	15.4	37.1	10.1	0.1	0.1	0.1	0.3
Bhutan	0.1	0.4	15.9	(.)	(.)	0.1	0.2
India	681.7	1342.1	6.9	3	4.6	0.6	1.2
Maldives	0.2	0.7	26.5	(.)	(.)	0.7	2.5
Nepal	0.6	3	27.3	(.)	(.)	(.)	0.1
Pakistan	68	125.6	6	0.3	0.4	0.6	0.6
Sri Lanka	3.8	11.5	14.8	(.)	(.)	0.2	0.6
South Asia	990.7	1954.6	6.8	4.4	6.7	0.8	1.3
Developing countries	6831.1	12303.3	5.7	30.1	42.5	1.7	2.4
World	22702.5	28982.7	2	100	100	4.3	4.5

Source: Human Development Report (2007-2008), United Nations

information, timeliness of information and trustworthiness of information are three important aspects that have to be delivered to farmers to meet their needs and expectations. But, countries have to be more proactive in using these technologies since the conventional tools and technologies for extension have become obsolete.

Table 1.21: Communication in South Asia and World

(Number)

Country/Region	Telephone lines per 1000 people		Cellular subscribers per 1000 people		Internet users per 1000 people	
	1990	2005	1990	2005	1990	2005
Bangladesh	2	8	0	63	0	3
Bhutan	3	51	0	59	0	39
India	6	45	0	82	0	55
Maldives	29	98	0	466	0	59
Nepal	3	17	0	9	0	4
Pakistan	8	34	(.)	82	0	67
Sri Lanka	7	63	(.)	171	0	14
South Asia	7	51	(.)	81	0	52
Developing countries	21	132	(.)	229	(.)	86
World	98	180	2	341	1	136

(.) Negligible

Source: Human Development Report (2007-2008), United Nations

Outside Development Assistance for National Development

Many countries depended on outside development assistance in the face of their resource crunch as well as the advantage of such assistance which is time bound, target oriented and may rigger the development rapidly. The lessons learnt through such assisted projects will help to design national projects well subsequently. We can see that such assistance as a percent of GDP was considerable in Sri Lanka, Maldives, Bhutan, Nepal and Bangaldesh, though the level is getting reduced for the past few years (Table 1.22).

Availability of Arable Land

In the 1980s, the arable land per thousand population varied between 0.05 ha in Sri Lanka and 0.64 ha in Afghanistan. But in 2005, it had considerably reduced in each country and varied from 0.05 ha in Sri Lanka to 0.33 ha in Afghanistan. In other words, the deceleration in growth in land area was 2.03% during this period. Thus, the increase in agricultural production in these countries has to come mainly through productivity growth (Table 1.23).

Size of Landholding

Land is an invaluable asset to farmers in South Asia as a factor of production and a symbol of social status. Owing to population pressure and social change towards breaking up of joint families, the size of landholding is drastically reducing across all countries. The average size of holding is maximum in Pakistan (3 ha), whereas it is 0.5 ha in Bangaldesh. Making this tiny landholding economical is a major challenge. Further, the distribution of

Table 1.22: Official development assistance (ODA) to South Asia and world

Country/Region	Total (million US $) 2005	Per capita (US $) 2005	As % of GDP 1990	As % of GDP 2005
Bangladesh	1320.5	9.3	6.9	1.7
Bhutan	90	96.1	15.4	10.7
India	1724.1	1.6	0.4	0.2
Maldives	66.8	203	9.7	8.7
Nepal	427.9	15.8	11.7	5.8
Pakistan	1666.5	10.7	2.8	1.5
Sri Lanka	1189.3	60.7	9.1	5.1
South Asia	9937.5	6.3	1.2	0.8
Developing countries	86043	16.5	1.4	0.9
World	106372.9	16.3	0.3	0.2

Source: Human Development Report (2007-2008), United Nations

Table 1.23: Arable land and population density

Country	Arable land / 1000 population		Growth, (%)	Population density (people/sq. km)		Growth, (%)
Year→	1985	2005		1999	2006	
Afghanistan	0.64	0.33	-3.20	-	-	-
Bangladesh	0.09	0.05	-2.61	981	1198.4	2.90
Bhutan	0.30	0.20	-2.02	-	14.0	-
India	0.21	0.14	-2.03	336	373.3	1.52
Nepal	0.13	0.09	-2.16	164	193.3	2.38
Pakistan	0.21	0.13	-2.26	175	206.3	2.38
Sri Lanka	0.05	0.05	-0.22	294	307.7	0.65
South Asia	0.21	0.14	-2.03	-	313.6	-

Source: FAO data

landholdings is highly skewed. In terms of number of holdings, households with less than 1 ha size form about 36% in Pakistan, whereas it is 85% in Bangaldesh. Contrastingly, households with less than 1 ha operate only 6% area in Pakistan, whereas it is 43% in Bangaldesh. Thus, both from farm-size and its distribution, land poses a great challenge for development (Table 1.24).

Table 1.24: Distribution of landholdings in South Asian countries

(in percent)

Area (ha)	Bangladesh	India	Nepal	Pakistan	Sri Lanka
Year	1996	1996	2002	2000	2002
Percentage of farms					
<0.8					62
<1.0	87	62	75	36	
1.0-2.0	9	19	18	22	
>0.8					38
>2.0	4	19	7	42	
Percentage of farm area					
<0.8					28
<1.0	43	17	39	6	
1.0-2.0	26	19	30	10	
>0.8					72
>2.0	31	64	31	84	
Average size of holding (ha)					
	0.5	1.4	0.8	3	0.8

Source: Joshi *et al*. (2007)

Sources of Increase in Agricultural Production

Apart from land, the other critical inputs contributing to increase in agricultural production are fertilizer, irrigation and mechanization. As regards fertilizer consumption, the major (NPK) nutrients use per ha has increased from 37 kg/ha in 1985 to 89 kg/ha in 2005 in South Asia. Maximum growth in fertilizer use was found in Bangladesh (5.5%), followed by almost equal growth of about 4.3% in India and Pakistan (Table 1.25). In case of irrigation, maximum irrigated area growth during 1985-2005 was observed in Bangladesh (4.8%), it was 1.6% in India and only 0.6% in Pakistan and similarly less than 1% in other countries against 1.7% in South Asia (Table 1.26). It can also be seen from Table 1.27, that the availability of water (total renewable per capita (actual)(m^3/inhab/yr) is decreasing fast over the years in all the South Asian countries at the annual rate of 2%. It has already reduced by half during the past 50 years. In case of mechanization (tractorization), maximum growth was found in India (7%), 4.7% in Bhutan, 2.1% in Sri Lanka as compared to 5.8% in South Asia and 0.54% in the World (Table 1.26). The percentage of irrigated area was only 32% in India, as compared to 70% in Pakistan and 54% in Bangaldesh. It is only 8.3% in Afghanistan, 7.1% in Bhutan, 28% in Nepal, 24% in Sri Lanka and 31% in South Asia (Table 1.28).

Falling Total Factor Productivity (TFP): A Major Concern

The total factor productivity (TFP) studies made in different countries of South Asian region during different time periods are given Table 1.29. It can be seen in general that the TFP is falling in majority of the crops in recent years as compared to earlier periods. For example, in case of rice, it had increased from 0.64% to 1.08% in India during the period 1971-86 to 1986-2000. However, in the Indo-Gangetic Plain of India, it had declined from

Table 1.25: Fertiliser consumption in South Asian countries

Country	Fertiliser (NPK kg/ha)		
Year	1985	2005	Growth, %
Afghanistan	1.9	1.0	-3.0
Bangladesh	55.5	173.0	5.8
Bhutan	0.2	2.2	12.2
India	47.9	113.1	4.4
Maldives			
Nepal	10.0	10.7	0.3
Pakistan	59.0	137.5	4.3
Sri Lanka	84.1	116.6	1.6
South Asia	37.1	89.1	4.5

Source: FAO data

Table 1.26: Annual growth rates in irrigated area, fertilizer consumption and number of agricultural tractors in use in South Asia, 1985 to 2005

Country	Irrigatedarea	Fertiliser	Stock of Tractor
Afghanistan	1.0	-3.0	0.6
Bangladesh	4.8	5.8	0.5
Bhutan	0.3	12.2	4.7
India	1.6	4.4	7.0
Nepal	2.3	0.3	0.8
Pakistan	0.6	4.3	3.1
Sri Lanka	0.5	1.6	2.1
South Asia	1.7	4.5	5.8

Source: FAO Data

Table 1.27: Water resources: Total renewable per capita (actual) in South Asian countries

(m^3/inhab/yr)

Year	1962	1967	1972	1977	1982	1987	1992	1997	1967-97 (Annual growth, %)
Afghanistan	6507	5875	5221	4710	4850	5448	4425	3337	-1.68
Bangladesh	21224	18712	16492	14623	12970	11481	10233	9205	-2.25
Bhutan	402915	351172	296847	247371	213538	184980	177580	183859	-2.07
India	4086	3682	3305	2952	2632	2353	2113	1913	-2.05
Maldives	293	264	236	207	179	153	131	116	-2.48
Nepal	20177	18384	16571	14839	13247	11807	10462	9233	-2.11
Pakistan	4639	4091	3584	3119	2650	2202	1892	1676	-2.70
Sri lanka	4903	4344	3882	3522	3251	3039	2852	2721	-1.61
South Asia	464744	406524	346138	291343	253317	221463	209688	212060	-2.09

Source: FAO data

Table 1.28: Irrigated area in South Asia: 1985-2005

Country	Irrigated area, %		Growth, %
Year	1985	2005	1985-2005
Afghanistan	6.8	8.3	1.0
Bangladesh	21.3	53.9	4.8
Bhutan	6.8	7.1	0.3
India	23.3	31.9	1.6
Maldives			
Nepal	17.6	27.7	2.3
Pakistan	61.5	69.6	0.6
Sri Lanka	21.6	23.7	0.5
South Asia	22.0	30.6	1.7

Source: FAO Data

3.5% during 1980-90 to 2.08% during 1991-2000. In case of livestock, in the Indo-Gangetic Plain, it had increased from 0.93% during 1970-80 to 1.79% during 1980-95. In Bangaldesh, it had increased in case of crops, livestock and crops, and livestock. In case of Nepal, it had increasd in case of crops, and crops and livestock, but had declined in livestock. In case of Pakistan, it had decreased in case of crops and livestock from 2.7% to 1.9% during 1977-82 to 1983-1988. However, during 1988-92 to 1993 to 1997; it had increased from 2.7% to 4.2%. In case of Sri Lanka, it was highly negative in case of crops and crops and livestock but improved from negative TFP (2.19%) to 1.3% in case of livestock during 1961-80 to 1981-2001. Thus, though there is no uniform trend, they are declining for all enterprises in general.

Trends in Government Expenditure on Agriculture

Though agriculture continues to be important for economic growth and food security in the region, the percentage of government expenditure as a percentage of total government expenditure has come down in every country of the region. For example, it decreased in India from 12.6% in 1985 to 9.6% in 1993, 15.7% to 6.9% in Bangaldesh, drastically in Nepal (22% to 10.5%) and Sri Lanka (20% to 5.10%). It is unfortunate that whenever there is an exercise on budget cut in any of these countries, the first victim is agriculture in general and agricultural research and education in particular (Table 1.30).

Agricultural Research Intensity Ratios

One of the useful, internationally comparable, indicators of the level of national agricultural R&D is research intensity, measuring total public agricultural R&D spending as a percentage of agricultural GDP. All the countries in the region invested less than 0.53 USD for every 100 USD of agricultural output which of course is slowly rising over the years. It is important to note that the South Asian countries' investment intensity is still very low compared with other developed countries. It is generally suggested to spend 1% of

Table 1.29: TFP growth for crops and livestock in South Asian Countries

Commodity		**India**	
Year →	1971-86	1986-00	Source
Paddy	0.64	1.08	Kumar *et al*. (2008)
Wheat	1.28	0.68	
Coarse cereals	1.36	0.12	
Pulses	0.52	-0.39	
Oilseeds	0.14	0.33	
Fibres	1.03	-0.05	
Sugarcane	0.79	-0.1	
Vegetables	2.59	-0.19	
		Indo-Gangetic Plain	
Year →	1980-90	1991-00	
Rice	3.5	2.08	Joshi *et al.* (2003)
Wheat	2.44	2.14	
Crops	2.01	-0.02	Kumar *et al*. (2004)
Livestock	1970-80	1980-95	Birthal *et al*. (1999)
	0.93	1.79	
Crop & livestock	1980-89	1990-94	Fan *et al*. (1999)
	2.52	2.29	
		Bangladesh	
Year	1961-80	1981-01	Avila and Evension (2004)
Crops	-0.23	1.06	
Livestock	0.75	2.65	
Crops & livestock	-0.01	1.3	
		Nepal	
Year	1961-80	1981-01	Avila and Evension (2004)
Crops	0.2	2.42	
Livestock	1.36	1.11	
Crops & livestock	0.5	2.1	
		Pakistan	
Year	1966-94		Pasha *et al.* (2002)
Crops	1.26		
Livestock	1.25		
Crops & livestock	1977-82	1983-1988	
	2.7	1.9	
	1988-92	1993-97	
	2.7	4.2	
		Sri Lanka	
Year	1961-80	1981-01	Avila and Evenson (2004)
Crops	-0.39	-1.21	
Livestock	-2.19	1.3	
Crops and livestock	-0.93	-0.92	

Source: Compiled by authors from different sources

Table 1.30: Percentage of government expenditure on agriculture in total government expenditure in South Asia: 1975-1993

Country	1975	1985	1993
Bangladesh	11.0	15.7	6.9
India	9.7	12.6	9.6
Nepal	15.3	22.0	10.5
Pakistan	6.7	2.9	2.6
Sri Lanka	9.0	20.0	5.1

Expenditure includes those at both central and local government levels
Source: Fan and Pardey (1998)

agricultural GDP on agricultural research and from the general recommendation, all the countries are to increase their agricultural research investment. It is to be noted that low capital intensity constrains research productivity and it is premature to hope that private capital will and can fill this void (Jha and Kumar, 2006).

Dietary Revolution to Guide Agricultural Diversification

Diet is changing universally across all groups of population, irrespective of economic, social and age differences. Horticulture, fishery, and livestock products are gaining importance in the diets of even the poorest of the poor, though cereals still dominate their food basket. These changes have to be responded by cropping pattern changes, and agricultural production, processing marketing practices (Table 1.31).

Table 1.31: Change in commodity composition of food in South Asia

(kg/capita/year)

Commodity	Low income growth			High Income growth		
	2000	2025	Change, %	2000	2025	Change, %
Rice	75.3	72.9	-3.1	75.3	72.1	-4.2
Wheat	60.5	59.4	-1.8	60.5	57.1	-5.6
Coarse cereals	22.2	20.2	-9.1	22.2	19.3	-13.2
Total cereals	158.0	152.5	-3.5	158.0	148.6	-6.0
Pulses	10.1	11.1	9.5	10.1	11.9	17.1
Total foodgrains	168.1	163.6	-2.7	168.1	160.4	-4.6
Roots & tubers*	4.9	5.7	16.1	4.9	6.4	28.7
Sweeteners	23.5	24.8	5.5	23.5	25.7	9.4
Vegetable oils	7.7	8.4	9.7	7.7	8.9	16.6
Vegetables	52.0	71.6	37.7	52.0	87.5	68.3
Fruits	35.2	49.5	40.7	35.2	61.8	75.8
Milk	70.4	95.8	36.1	70.4	117.5	66.0
Meat	5.4	8.2	53.2	5.4	10.9	103.6
Eggs	1.5	2.3	52.3	1.5	3.0	100.5
Fish	5.7	8.5	49.2	5.7	11.3	98.1

*Dry equivalent
Source: Joshi *et al.* (2007)

Table 1.32: Wastage of food (% of total domestic supply)

Country/Region	Cereals	Pulses	R&T Dry Equiv	Veg	Fruits	Milk
Bangladesh	6.66	3.54	9.67	9.24	9.41	7.54
India	3.41	3.31	13.27	6.7	13.69	1.2
Nepal	10.89	4.9	14.34	9.79	8.14	4.6
Pakistan	2.84	1.83	7.83	3.98	3.71	8.47
South Asia	3.92	3.23	12.61	6.7	12.49	3
Sri Lanka	4.76	3.15	5.91	11.27	10.83	1.49
World	4.19	4.77	10.13	8.69	8.96	1.8

Source: FAO Data

Post-Harvest Losses — Substantial

In the context of resource-poor farmers, it is important that economic benefits of agro-processing and agri-business are taken to the rural areas. The post-harvest losses are substantial in fruits & vegetables and roots & tubers across commodities and countries (Table 1.32).

Appendix 2

Regional Priorities for 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-safely 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 addition
3.6 Competitiveness
3.7 Product/quality improvement and standards
3.8 Quarantine and bio-security
4. Meeting the Protein Demand of Growing Population (Animal)
4.1 Feed resource: fish, poultry, ruminants and non-ruminants (forage, pasture, fodder, grain, constituted feed stocks and crop residues)
4.2 Disease management (poultry, ruminants, non-ruminants, aquaculture)
4.3 Production systems (crop/livestock, acquaculture, mariculture)
4.4 Waste management and by-product utilization
5. Meeting the Protein Demand of 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 safely: aflatoxins and anti-nutrition factors
6. Tree and Forest Management for Landholders
6.1 Natural forest management
6.2 Harvesting regime and regeneration
6.3 Cutting cycle analysis
6.4 Forest plantation, productivity and health
6.5 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

Appendix 3

Priorities in Agriculture in South Asian Countries

Afghanistan	Bangaldesh	Bhutan	India
• Strengthen government and community based organizations • Improve irrigation water supply by strengthening irrigation systems • Provide support in input, credit and service provision • Tackle the opium economy • Expand access to technology • Strengthen marketing system • Sustainable use of natural resources	• Manage frequent floods • Water management • Strengthen rural infrastructure • Improve rice productivity • Diversify towards high-value enterprises • Involve NGOs in technology dissemination, provision of credit and linking smallholders with market	• Improve labour productivity in agriculture • Improve rural communication • Selective farm mechanization • Strengthen research and extension system • Protection of agricultural crops from wild animals • Diversify particularly towards horticulture • Promote organic farming • Support community based rural development	• Enhance agricultural productivity • Enhance public investment in research and infrastructure • Strengthen agri diversification • Strengthen R-E-F-Market linkage • Promote PPP • Strengthen NRM practices • Strengthen support, service and policies • Strengthen rural non-farm growth • Promote community based rural development
Maldives	**Nepal**	**Pakistan**	**Sri Lanka**
• Strengthen tourism • Strengthen fishery, particularly women role • Strengthen policy, service, support system to utilize uninhabitated islands with PPP • Prepare for sea level rise • Strengthen fiscal environment through institutional reforms	• Strengthen NRM • Strengthen non-agri sector, encouraging manufacturing sector • Work towards political stability and management of conflicts • Strengthen communication and other basic infrastructure for research and extension system, service and supply system like credit and other critical inputs • Strengthen irrigation and commercialization	• Review positive policy reforms to contribute to accelerated growth • Rehabilitate and modernize irrigation system • Manage water and soil fertility • Strengthen input supply system, particularly quality seed • Strengthen research and extension • Strengthen institutional linkage between agriculture and non-agriculture sectors	• Enhance agriculture, labour productivity to improve competitiveness • Strengthen research and extension system • Strengthen horticulture and dairy sectors • Strengthen irrigation and water management • Strengthen rural credit, market and other services • Improve use of modern technologies • Review the restrictive land policy and other regulatory mechanisms • Foster private sector participation • Enable rural non-farm growth

Source: SAARC, 2008; DARE, 2000

Appendix 4

Priorities in Agriculture for Asia

CGIAR: Prioritizing Areas of Work by Asia Panel (Indicative allocation of 200 voting points)

Germplasm Improvement (45)
1. Enhancing germplams through conventional approaches
2. Enhancing germplasm through biotechnology
3. Characterization of genetic traits in plants and animals
4. Stress resistance in food staples
5. Nutritional content of food staples
6. Work on high-value crops with export potential

Germplams Collection and Conservation, Saving Biodiversity (15)
1. Sustaining biodiversity
2. Help partners live up to international obligations (e.g. CBD)
3. Collect, conserve, evaluate, enhance, distribute, etc. germplasm

Sustainable Production System (45)
1. Defining production potential of the natural resource base
2. Synthesis, storage, dissemination of NRM information
3. Integrated Natural Resources Management: develop
4. Effective pest management/Integrated pest management
5. Integrated crop and livestock system
6. Forage and feed crops as component of systems
7. Integrated Nutrient Management Systems
8. Small-scale water management and water use efficiency
9. System for drought-prone areas
10. Farm mechanization

Improving Policies (25)
1. Public and private sector issues
2. Incentives and market: input and output markets, seed
3. Study opportunities for post-harvest value-added processing
4. Understanding farmers' acquisition and use of nutrients
5. Studies to improve the funding levels/allocation of resources
6. Better understanding of poverty dynamics (especially in LFAs)

Strengthening NARSs and other Rural Institutions (25)
1. Training of scientists and research managers
2. Training materials on crops
3. Research on empowerment of farmers and communities
4. Build organization and management capacity NARIs
5. Research on agri innovation systems and innovation processes
6. Builing capacity of SROs (sub-regional organizations)

Crosscutting Activities and Outputs (45)
1. Identifying poverty: mapping location and correlates of the poor
2. Development of new research tools (e.g., biotechnology, genomics)
3. Development of new information tools (e.g., GIS, modelling of systems)
4. Doing better, stronger impact work in and on the system

Source: CGIAR (2003)

Appendix 5

Summary of Major Food Security Programmes in South Asian Countries

Countries	Programmes and steps taken for food security	Target population	Coverage and implementation	Aspect of food security[1]
Afghanistan	World Food Programme	Chronically-poor and food-insecure families, schoolchildren, teachers, illiterate people, tuberculosis patients and their families, internally displaced persons and ex-combatants – with a particular emphasis on vulnerable women and girls.	3.7 million people each year. Since January 1, 2006.	Vulnerability
Bangladesh	Public Foodgrain Distribution System (PFDS)	Poorest population	Launched in 1975	Availability and Accessibility
Bhutan	Receive support from several multilateral and bilateral development agencies.			
	Food Corporation of Bhutan	Farmers	Established in 1974	Accessibility and Availability
India	Public Distribution System	Below Poverty Line Population	It is intended to serve poor who number more than 330 million	Accessibility and Vulnerability
	Mid-day Meal Scheme	Students in government primary schools/ primary schools aided by government and run by local bodies.	Scheme covers students of Class I-V and was launched in 1995	Utilisation

[1] The policy targets one of the four pillars of food security — Availability, Access, Utilisation and Vulnerability.

Countries	Programmes and Steps taken for Food security	Target Population	Coverage and implementation	Aspect of food security[1]
	Village Grain Banks Scheme	The revised scheme envisages inclusion of all willing BPL/ AAY families in the villages which are to be identified by the State Govt. in food-deficit areas	Launched during 1996-97 by the Ministry of Tribal Affairs in 11 States; since 2004, the scheme is being implemented by the Department of Food & Public Distribution.	
	National Food for Work Programme (NFFWP)	All rural poor who are in need of wage employment and desire to do manual and unskilled work.	150 most backward districts of India. Launched in 2000.	Accessibility
	Antyodaya Anna Yojana	5 % of the total population in the country who sleep without two square meals a day	One crore of the poorest families; launched in 2000.	Accessibility and Vulnerability
	Integrated Child Development Scheme	Children and pregnant women	Scheme was launched in 1975 in 33 Community Development Blocks. It covers 6118 blocks in the country including 4790 in rural areas, 805 in tribal areas and 523 in urban slums.	Utilisation
	Essential Commodities Act, 1955	General public	Launched in 1955 and extends to whole of India	Availability
	National Food Security Mission		Launched in 2007	Availability
	Rashtriya Krishi Vikas Yojana (National Agriculture Development Scheme)	Farmers	Covers all the states and UTs and was launched in 2007.	

Countries	Programmes and Steps taken for Food security	Target Population	Coverage and implementation	Aspect of food security[1]
	Targeted Public Distribution System	Below Poverty Line	Scheme was intended to benefit about 6 crore poor families; launched in 1997	Accessibility and Vulnerability
	National Rural Employment Guarantee Act (NREGA)	Rural households primarily semi-skilled or unskilled workers living below the poverty line in rural India	Launched in 2005	Accessibility and Vulnerability
	Sampoorna Grameen Rozgar Yojana (SGRY)	Women, scheduled castes, scheduled tribes and parents of children withdrawn from hazardous occupations	Launched in 2001 in all states and UTs	Accessibility
Maldives	Hydroponics Agriculture Pilot Project	Youth and school children	Taken up in 2006	Utilisation and Vulnerability
	Food Safety advocacy sessions (I & II)		May, 2005	Utilisation and Vulnerability
Nepal	Nepal Food Corporation	People in hill and mountain areas where there is food deficiency	Established in 1974	Accessibility and Vulnerability
Pakistan	No food security programme as such - rather plethora of food laws. Only government of Punjab has a food policy but that considers only wheat for the food security policy and ignores the other components of food security.			Availability
Sri Lanka	There are food-based welfare programmes and not food security programmes: Samurdhi programme	People below poverty line	Two million households. Started in 1995	Accessibility

Countries	Programmes and Steps taken for Food security	Target Population	Coverage and implementation	Aspect of food security[1]
	Thriposha programme	Mothers among low income groups with infants under one year of age (lactating mothers)	Launched in 1973 and covers 600,000 beneficiaries	Utilisation
	School mid-day meal programme	Children	Covers 500,000 children in 6, 440 schools; started in 2004.	Utilisation and Vulnerability

Source: Surabhi and Deepti (2009)

Appendix 6

Research Prioritization in Agriculture: Data, Methodology and Results

Studies on research priority setting are generally carried out using 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. The choice of the model is guided by the level of priority setting (macro or micro) and availability of data, analytical skills and resources. The present study followed the modified congruence model because of the ease of its application, time and data constraints. 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 research benefits are proportional to the value of output. The analysis is based on the present values and assumes constancy of relative shares. These restrictive assumptions imply that results of this exercise provide only a sound starting point in rationalizing research resource allocation. The CGIAR (1992) and the Indian agricultural research system (Jha *et al*., 1995; APAARI, 2002; Mruthyunjaya *et al*., 2003) also followed this approach because of its simplicity, transparency and flexibility.

Trends in Food Demand

In order to capture the effects of changes in the demand on commodity priorities, VOP of a commodity has to be adjusted with the expected growth in its demand in the country. Since research and extension lag is about 8-11 years, the growth has to be extrapolated to 2015 and 2025. This adjustment in VOP implies that commodities with higher expected growth in the demand should get high priority. The food demand is estimated based on food characteristics demand system (FCDS) (Bouis and Haddad, 1992) using consumption data from FAO.

In South Asia, while cereals remain important constituents of the food basket, high-value foods such as fruits, vegetables, milk, meat, eggs and fish are rising in importance. Trends in food consumption pattern over the past two decades suggest changes in the composition of the food basket from coarse grains to superior grains (rice and wheat), and from grains to livestock and horticultural products. This has significant implications for future food demand, research priority setting, and resource allocation to achieve food and nutritional security.

Tables 6.1 and 6.2 present the projected food demand and annual growth in South Asian countries for the years 2015 and 2025. It is evident that in 2025, food grain demand will be of 339 million tons, comprising 147 million tons rice, 122 million tons wheat, 46 million

Table 6.1: Projected demand for food in South Asia

(Thousand tons)

Commodity	Year	Bangladesh	India	Nepal	Pakistan	Sri Lanka	South Asia
Rice	2005	22651	87460	3059	2981	2001	118151
	2015	25808	98107	3793	3751	2172	133631
	2025	28958	106575	4552	4552	2354	146991
Wheat	2005	2846	68044	1209	24433	910	97441
	2015	3278	74753	1471	30125	996	110623
	2025	3710	79863	1738	35968	1087	122367
Coarse cereals	2005	215	34271	1742	2304	87	38619
	2015	243	37331	2106	2821	92	42594
	2025	271	39612	2477	3349	99	45809
Pulses	2005	606	15129	224	1472	161	17592
	2015	719	17864	288	1896	185	20952
	2025	833	20221	356	2343	210	23963
Edible oils	2005	672	9558	140	1911	68	12349
	2015	794	11191	178	2459	77	14699
	2025	916	12582	218	3039	86	16840
Sweeteners	2005	1257	28334	155	5022	592	35359
	2015	1469	32727	195	6381	664	41436
	2025	1683	36395	236	7803	740	46857
Roots & tubers	2005	579	7350	274	555	129	8888
	2015	689	8918	354	724	154	10839
	2025	801	10316	439	904	179	12639
Vegetables	2005	1817	78166	1814	6567	815	89180
	2015	2235	102182	2454	8907	1043	116821
	2025	2666	125482	3156	11478	1289	144071
Fruits	2005	1503	52188	557	7432	946	62627
	2015	1889	68660	765	10283	1165	82763
	2025	2293	84750	995	13466	1397	102901
Milk	2005	2395	88922	1423	34160	885	127784
	2015	2977	114108	1934	46395	1118	166532
	2025	3581	138059	2498	59851	1369	205359
Meat	2005	459	5494	302	2248	112	8615
	2015	589	7536	424	3094	147	11790
	2025	727	9619	562	4033	185	15127
Eggs	2005	195	2068	31	410	54	2758
	2015	250	2837	43	565	71	3766
	2025	309	3622	57	736	89	4812
Fish	2005	1555	7234	33	514	496	9831
	2015	1995	9923	46	707	649	13320
	2025	2462	12666	61	922	817	16928

Source: Kumar *et al.* (2007)

Table 6.2 : Projected growth in demand for food in South Asia

(in per cent)

Commodity	Year	Bangladesh	India	Nepal	Pakistan	Sri Lanka	South Asia
Rice	2005-15	1.31	1.16	2.17	2.32	0.82	1.24
	2015-25	1.16	0.83	1.84	1.95	0.81	0.96
Wheat	2005-15	1.42	0.94	1.98	2.12	0.91	1.28
	2015-25	1.25	0.66	1.68	1.79	0.88	1.01
Coarse cereals	2005-15	1.23	0.86	1.92	2.05	0.56	0.98
	2015-25	1.10	0.59	1.64	1.73	0.74	0.73
Pulses	2005-15	1.72	1.68	2.54	2.56	1.40	1.76
	2015-25	1.48	1.25	2.14	2.14	1.28	1.35
Edible oils	2005-15	1.68	1.59	2.43	2.55	1.25	1.76
	2015-25	1.44	1.18	2.05	2.14	1.11	1.37
Sweeteners	2005-15	1.57	1.45	2.32	2.42	1.15	1.60
	2015-25	1.37	1.07	1.93	2.03	1.09	1.24
Roots & tubers	2005-15	1.75	1.95	2.59	2.69	1.79	2.00
	2015-25	1.52	1.47	2.18	2.25	1.52	1.55
Vegetables	2005-15	2.09	2.72	3.07	3.09	2.50	2.74
	2015-25	1.78	2.08	2.55	2.57	2.14	2.12
Fruits	2005-15	2.31	2.78	3.22	3.30	2.10	2.83
	2015-25	1.96	2.13	2.66	2.73	1.83	2.20
Plantation & others	2005-15	1.75	1.95	2.59	2.69	1.79	2.00
	2015-25	1.52	1.47	2.18	2.25	1.52	1.55
Milk	2005-15	2.20	2.53	3.12	3.11	2.36	2.68
	2015-25	1.86	1.92	2.59	2.58	2.05	2.12
Meat	2005-15	2.53	3.21	3.45	3.25	2.76	3.19
	2015-25	2.13	2.47	2.86	2.69	2.33	2.52
Eggs	2005-15	2.52	3.21	3.33	3.26	2.77	3.16
	2015-25	2.14	2.47	2.86	2.68	2.29	2.48
Fish	2005-15	2.52	3.21	3.38	3.24	2.73	3.08
	2015-25	2.13	2.47	2.86	2.69	2.33	2.43

Source: Computed from Table 6.1

tons coarse grains and 24 million tons pulses. By the year 2025, South Asia will need 13 million tons roots and tubers (in dry equivalent), 17 million tons edible oils, 144 million tons vegetables, 103 million tons fruits, 47 million tons sweeteners, 205 million tons milk, 15 million tons meat, 4.8 million tons eggs, and 16 million tons fish to meet its domestic demand (assuming 3.5% growth in per capita income). High growth in livestock products' demand will put a pressure on food grains and oilcakes to meet the feed demand for livestock. Fast growth of income will diversify the dietary pattern in favour of non-foodgrain crops,

livestock and fisheries products. The per capita availability of arable land in South Asia is quite low and is declining over time. Diversification towards these high-value commodities, which are labour-intensive, can also provide adequate income and employment to the agricultural labourers and small farmers who dominate the agriculture in these countries. It is important to make significant efforts to increase in yield per unit of inputs using science, by accelerating TFP, as the required yield targets would be quite challenging to attain national food and household nutritional security in South Asia. To meet the future demand for food and to maintain self-sufficiency, the South Asian region must attain a per hectare average yield of 2.4 tons for rice, 3.4 tons for wheat, 1.4 tons for coarse cereals and 1.02 tons for pulses by the year 2025. The productivity needs to be doubled for horticultural crops, livestock and fisheries. The growth targets for productivity need to be fixed at about 1 percent for cereals, 2 percent for pulses, 2.5 percent for edible oils, 3.5 percent for vegetables, fruits, and milk, and 4 percent for meat, eggs and fish. The trends thus suggest that (i) these countries have not only to produce additional food but also diversify food production towards products of higher nutritional value, (ii) the targets to be achieved are quite challenging, and (iii) the research system has to proactively respond through structural and functional changes. Research priorities have to be worked out keeping in view these trends in demand. To address such a challenge, the goals and objectives of the research system should be changed and the priorities identified should contribute to achieve those goals.

Identification of Goals, Research Objectives and Extensity Parameters

For the prioritization analysis, the goals normally emphasized in the national documents of the governments, namely growth, equity, sustainability (of the resources) and export are taken. They help in identification of research objectives. The identification of research objectives and their extensity parameters (indicators) and weights for the construction of initial baseline (IBL) is the most crucial step in the priority setting exercise. In the construction of IBL, only extensity parameters are taken as these reflect that the size of the problem to be addressed by the research system is large. The selected research objectives and their extensity parameters along with weights are given in Table 6.3. Prioritization of commodities and regions (countries) involves calculation of an initial baseline matrix consisting of the value of output from different commodities in different countries. A composite baseline was then developed using the value of output (efficiency), number of poor people (equity), and arable land (sustainability) indicators, and export (agricultural export earning) using equal weights for these four parameters

A comprehensive data set was compiled for each country, covering a large number of variables. The data are centered on the year 2005. These were obtained from various published sources described at the end of tables.

Extensity Parameters

1. Value of output (VOP), current value of 17 commodities/commodity groups, projected for 2010, 2015 and 2025: The priorities are defined to meet the future demands of

Table 6.3: IBL - based goals, objectives and extensity parameters of agricultural research system in South Asia

S. No.	Goal	Research objective	Extensity parameter	Weight (%)
1.	Growth acceleration	Increase in productivity	Value of production	25
2.	Equity	Increase in income of people below poverty line	Number of people below poverty line	25
3.	Sustainability of production	Sustainable use of natural resources	Arable land	25
4.	Improvement in balance of payment	Proportion of export	Agricultural export earning	25

commodities with 3.5% per capita GDP growth rate and the accompanying dietary changes. Research prioritization targeting poor income farmers is also attempted using Indian case to highlight the significance of need for research prioritization targeting poor rather than all groups, as is being done at the present.

2. Poverty: Number of people below the national poverty line in each country.

3. Sustainability: Land area (arable land and forests) in each country.

4. Export: Agricultural export earning of each country.

The importance of extensity parameters suggest that research activities should focus in the area (country) where value of correspond $B_i = (\sum_{j=1}^{k} W_j \; P_{ij}); \; i = 1, ..., n$

Initial baseline (IBL) is the weighted sum of extensity parameters. In the absence of precise prior information on relative importance of different objectives, equal weights (0.25) were assigned to all the extensity parameters. The value of production was computed using international prices.

The construction of initial baseline (IBL) can be illustrated by the following steps:

1. Compute percentage distribution of each extensity parameter (P)

$$P_{ij} = (A_{ij} / \sum_{i=1}^{n} A_{ij}) \times 100; \; i = 1, ... n; j = 1, ... k$$

where, A_{ij} is value of j^{lh} parameter in i^{lh} agro-ecoregion, n is the number of ecoregions and k is the number of extensity parameters.

2. Assign weight (W_j) to each extensity parameter.

3. Compute initial baseline (B_i)

Value of production (VOP) reflects the research objective of increase in productivity. The VOP can be adjusted by supply side factors like probability of research success, expected level of adoption of research, research spill over, etc. But, these were not considered owing to lack of availability of prior information. The VOP unadjusted to supply side factors means assuming equal probability of research success and equal or no spill over effects across countries and commodities.

The extensity parameter, number of people below poverty line was selected to further strengthen research activities in the area where the number of poor people was comparatively high. This would help in reducing interpersonal and interregional disparities in the country. Agricultural production can be sustained through conservation of natural resources, particularly land and water. Land area was selected as one of the extensity parameters and land area comprised arable lands. Agricultural exports improve balance of payments situation and hence all governments intend to enhance exports and was thus included as a research objective and agricultural export earnings as an extensity parameter. Table 6.4 presents the per cent distribution of VOP, poverty (poor), sustainability (land) and exports by country in South Asia.

Table 6.4. Per cent distribution of value of output (VOP), poverty (poor), sustainability (land) and exports (EXPO) by country in South Asia

Goal	Bangladesh	Bhutan	India	Nepal	Pakistan	Sri Lanka	South Asia
VOP	7.23	0.06	75.50	1.71	14.45	1.06	100
Poor	14.55	0.05	71.96	0.09	12.01	1.35	100
Land	4.16	0.07	82.94	1.23	11.09	0.51	100
EXPO	6.47	0.21	76.43	0.67	11.51	4.71	100

The constructed IBL with different objectives for South Asian countries is given in Table 6.5. It can be seen that from the objective of VOP, poor, land, export enhancement and all together, the top 3 priority countries are India, Pakistan and Bangaldesh.

Table 6.5: Initial baseline (IBL) with different objectives

Objectives	Bangladesh	Bhutan	India	Nepal	Pakistan	Sri Lanka
VOP	7.23	0.06	75.50	1.71	14.45	1.06
VOP and Poverty	10.89	0.05	73.73	0.90	13.23	1.20
VOP, Poverty & Sustainability	8.64	0.06	76.80	1.01	12.52	0.97
All objectives (FVOP)	8.10	0.10	76.71	0.92	12.26	1.91
Ratio of FVOP/VOP	1.12	1.54	1.02	0.54	0.85	1.80

Modification of the Initial Base Line: Selection of Modifiers

The initial base line does not fully consider the intensity dimensions of growth, equity and sustainability, and, therefore, appropriate intensity parameters or modifiers are used for modifying the baseline. The idea is that a higher priority should be given to that country where intensity of the problem is severe. For example, the country with high groundwater exploitation should be accorded a high priority. Here, the direction of impact of modifier is positive. On the contrary, the country with low per capita income (indicating intensity of inequality) should be accorded a high priority. In this case, the direction of impact is negative. Thus, the selection of modifiers becomes highly crucial at this stage. Having selected the modifiers, the next step is to decide the weight to be attached to each modifier while quantifying its impact on the initial baseline. The sign of the modifiers should be appropriately considered to target the impact of the modifier in the desired direction while modifying the initial baseline. The following step is involved in quantifying the impact of modifiers:

$$\textit{Impact of modifiers (Cij)} = [1+\{M_{ij} / Max\ (M_{ij})\} \times W_j]\ B_i$$

where, M_{ij} denotes the data for *jth* modifier for the i^{th} country, Max (M_{ij}) denotes the maximum value of j^{th} modifier, and W_j is the weight for j^{th} modifier.

Modifiers may have positive as well as negative impact on initial baseline. The above formula holds true for the modifiers having positive impact. In case of modifiers carrying a negative sign, the direction has to be reversed. This is done by subtracting the standardized value of modifier $[(M_{ij} / Max\ (M_{ij})]$ from 1 and then multiplying by weight and the initial base line. The impact of each modifier is aggregated to get the total impact of all the modifiers. Using this aggregate impact, the initial baseline is modified by using the following steps to get the final baseline.

$$\textit{Adjusted baseline (Di)} = B_i + \sum_{i=1}^{k} Cij$$

$$\textit{New priority distribution or final baseline (Ei)} = (Di / \Sigma\, Di)^{n}_{i=1} * 100$$

Several modifiers were initially considered. Finally, based on the appropriateness arrived through review of literature and collective judgment, 6 modifiers were chosen for the study. Correlation studies among these modifiers indicated no duplication. The intensity parameters selected as modifiers were:

1. Growth potential: Irrigation (%) in each country
2. Water withdrawal per capita (m^3/inhab/yr)
3. Population density (population per sq. km)
4. Forest land (% of total land)
5. Average size of holding (ha)
6. Scientists (per million population) in each country

To take these into account, the composite initial baseline was modified by using intensity parameters or modifiers. After careful screening of the modifiers impact as well as multi-collinearity, modifiers, representing growth potential (irrigation), equity (size of holding), sustainability (water withdrawal, population density, forest land), research and extension system capacity (number of scientists per million population) were used.

Irrigation is one of the major inputs for enhancing productivity and hence was used as a modifier to enhance productivity. Water withdrawal per capita is increasing for different uses and contributes to unsustainable use and hence was used as a modifier. Increasing population density again contributes unsustainable natural resource use and was retained as a modifier. One more modifier used to reflect sustainable use of resources was area under forest. To reflect equity, farm size was used as a modifier as it decided the income earning potential of a farmer. One of the modifiers used to achieve the objective of adequate manpower to attain the goal of research system capacity was the number of qualified agricultural scientists per million population. Equal weights (25%) were used for each of these modifiers [equal weight (8.33%) to sub-modifiers under sustainability goal]. The parameters for prioritization and weighting schemes were decided on the basis of the information provided by the NARS. Details regarding these variables, their direction and weights are provided in Table 6.6. Personal judgement was used to identify and specify the objectives, extensity and intensity (modifier) parameters and weighting schemes and arrive at modified base line (MBL) with incorporates multiple objectives (Table 6.7). The modifier effect was

Table 6.6: FBL-based goals, objectives and modifiers for agricultural research system in South Asia

Goals	Research objectives	Country modifiers	Direction	Weight (%)
1. Growth acceleration	Increase in productivity	Irrigated area (% of total crop area)	Negative	25
2. Sustainability of production	Sustainable use of natural resource base	Water withdrawal per capita (m^3/inhab/yr)	Positive	8.33
		Population density (population per sq km)	Positive	8.33
		Forest land (% of total land)	Negative	8.33
3. Equity	Increase in income of small farmers	Average farm size (ha)	Negative	25
4. Research system capacity	Balanced development of research system infrastructure	Number of agricultural scientists per million population	Negative	25

positive and high for Bangladesh (1.40) and India (1.48). This effect was negligible for small economies, viz. Bhutan, Nepal and Sri Lanka. However, the effect was negative for Pakistan (-3.07). The Priority index (ratio of MBL and VOP) suggests that Bhutan, Sri Lanka and Bangladesh need higher resource allocation to meet the objectives of their development.

Table 6.7 Final baseline and impact of extensity and modifiers on South Asian countries

Base line	Bangladesh	Bhutan	India	Nepal	Pakistan	Sri Lanka
VOP	7.23	0.06	75.50	1.71	14.45	1.06
Final VOP (FVOP)	8.10	0.10	76.71	0.92	12.26	1.91
Modified base line (MBL)	9.50	0.13	78.19	1.03	9.19	1.96
Priority Index (MBL/VOP)	1.314	2.071	1.036	0.606	0.636	1.850
Modifier effect	1.40	0.03	1.48	0.11	-3.07	0.05

VOP: % share of gross output in South Asia at 1999-2001 international dollar

Strengths and Limitations

Strengths

1. The modified congruence method is the most commonly used methodology for research prioritization with explicit elicitation of goals, trade-off among goals, evaluates commodity research and ranks non-commodity research and relative ease of comprehension by decision makers.
2. Prioritization using demand driven approach with explicit focus on the poor.
3. Estimation of investment requirement of agricultural research for development to sustain food and nutritional security and social empowerment at current growth rate of AgGDP (2.1%) and targeted growth rate (4%).

Limitations

1. The data base had limitations of coverage and reliability
2. The approach did not consider past research investments which had obvious bearing on research resource allocation
3. There was a need to develop and use other modifiers to take into account probability of success, scope for spill-over, projected agricultural situation and other important factors

Country and Commodity Priorities

The modified congruence model gives priorities by commodities and countries (Table 6.8 and Table 6.9). This priority matrix can be used to arrive at different priority dimensions, such as country priorities (sum over commodities by countries), commodity priorities (sum over countries by commodity) or commodity group priorities for the region (sum over commodities and countries). In this exercise, country priorities, and commodity priorities within and across countries have been discussed. For the benefit of national programs, commodity priorities by

Table 6.8: Priority score of commodity groups by country in South Asian countries

Commodity	Year	Bangladesh	India	Nepal	Pakistan	Sri Lanka	South Asia
Rice	2005	45.9	14.1	19.4	4.8	22.1	17.6
	2015	43.7	12.9	18.4	4.6	20.2	16.2
	2025	41.8	11.9	17.7	4.4	18.8	15.1
Wheat	2005	2.1	8.6	7.2	12.5	0.0	7.5
	2015	2.0	7.7	6.7	11.6	0.0	6.8
	2025	1.9	7.0	6.3	11.0	0.0	6.2
Coarse cereals	2005	0.7	3.3	10.0	2.5	0.4	2.8
	2015	0.7	2.9	9.2	2.3	0.3	2.5
	2025	0.6	2.6	8.7	2.2	0.3	2.3
Cereals	2005	48.7	25.9	36.6	19.8	22.5	27.8
	2015	46.3	23.4	34.4	18.5	20.5	25.4
	2025	44.4	21.5	32.7	17.5	19.1	23.6
Pulses	2005	1.2	4.0	2.3	1.3	0.3	3.2
	2015	1.2	3.8	2.3	1.2	0.3	3.1
	2025	1.2	3.7	2.3	1.2	0.3	3.0
Edible oils	2005	1.4	9.7	2.0	6.8	11.9	8.7
	2015	1.4	9.2	2.0	6.6	11.3	8.3
	2025	1.4	8.9	1.9	6.4	10.9	7.9
Sweeteners	2005	1.3	3.7	1.5	4.0	0.7	3.2
	2015	1.2	3.4	1.5	3.8	0.6	3.0
	2025	1.2	3.3	1.4	3.7	0.6	2.9
Roots & tubers	2005	4.5	2.5	9.3	1.0	3.4	2.8
	2015	4.4	2.5	9.2	1.0	3.4	2.7
	2025	4.4	2.5	9.1	1.0	3.4	2.7
Vegetables	2005	3.8	8.6	12.6	1.5	6.9	7.5
	2015	3.9	9.1	13.1	1.5	7.4	7.9
	2025	4.0	9.6	13.5	1.6	7.9	8.2
Fruits	2005	2.5	8.9	4.3	5.2	1.8	7.3
	2015	2.6	9.5	4.5	5.4	1.8	7.8
	2025	2.7	10.0	4.7	5.6	1.9	8.2
Plantation	2005	2.3	6.8	1.3	5.6	34.1	8.3
crops	2015	2.3	6.7	1.2	5.5	34.2	8.1
	2025	2.3	6.6	1.2	5.5	34.2	8.0
Horticulture	2005	13.1	26.8	27.5	13.3	46.2	25.8
	2015	13.3	27.9	28.1	13.5	46.9	26.6
	2025	13.4	28.7	28.5	13.6	47.3	27.2
Milk	2005	5.3	18.3	14.9	35.7	1.9	16.8
	2015	5.5	19.2	15.6	36.6	2.0	17.7
	2025	5.6	19.8	16.0	37.2	2.1	18.4
Meat	2005	5.7	4.0	12.9	15.5	6.6	5.3
	2015	6.1	4.5	13.8	16.1	7.3	5.8
	2025	6.4	4.9	14.6	16.5	7.9	6.3
Eggs	2005	1.3	1.2	1.0	1.3	1.5	1.2
	2015	1.4	1.4	1.0	1.3	1.7	1.4
	2025	1.5	1.5	1.1	1.4	1.8	1.5
Livestock	2005	12.26	23.60	28.79	52.48	10.04	23.44
	2015	12.96	25.05	30.45	53.97	11.01	25.01
	2025	13.52	26.19	31.80	55.12	11.82	26.29
Fish	2005	22.05	6.38	1.26	2.37	8.41	7.89
	2015	23.62	7.13	1.35	2.46	9.26	8.63
	2025	24.90	7.76	1.43	2.53	10.00	9.25

Note: Adjuested value of output product was obtained for the year 2005 after taking into account extensity and intensity parameters as explained in methodology. The adjuested VOP has been projected for the years 2015 and 2025

Table 6.9: Priority score of commodity groups across South Asian countries

Commodity	Year	Bangladesh	India	Nepal	Pakistan	Sri Lanka
Rice	2005	29.1	58.8	0.8	1.9	9.5
	2015	29.4	58.5	0.8	2.1	9.1
	2025	30.0	57.8	0.9	2.3	9.0
Wheat	2005	3.1	84.7	0.7	11.6	0.0
	2015	3.2	83.3	0.7	12.8	0.0
	2025	3.3	81.8	0.8	14.0	0.0
Coarse cereals	2005	2.8	87.5	2.5	6.3	1.0
	2015	2.9	86.5	2.7	7.0	0.9
	2025	3.0	85.4	3.0	7.7	0.9
Cereals	2005	19.5	68.6	0.9	4.9	6.1
	2015	19.8	67.9	1.0	5.4	5.9
	2025	20.3	66.8	1.1	5.9	5.9
Pulses	2005	4.3	91.6	0.5	2.7	0.8
	2015	4.3	91.4	0.5	3.0	0.8
	2025	4.4	91.0	0.6	3.2	0.8
Edible oils	2005	1.8	82.2	0.2	5.4	10.4
	2015	1.8	82.1	0.2	5.9	10.0
	2025	1.9	81.6	0.2	6.5	9.9
Sweeteners	2005	4.4	85.0	0.3	8.6	1.6
	2015	4.4	84.3	0.4	9.4	1.5
	2025	4.5	83.4	0.4	10.2	1.5
Roots & tubers	2005	18.0	67.7	2.3	2.5	9.4
	2015	17.7	67.8	2.5	2.7	9.2
	2025	17.7	67.5	2.6	2.9	9.2
Vegetables	2005	5.7	84.7	1.2	1.4	7.0
	2015	5.4	85.0	1.2	1.5	6.9
	2025	5.2	85.0	1.3	1.5	6.9
Fruits	2005	3.8	89.1	0.4	4.9	1.8
	2015	3.6	89.1	0.4	5.2	1.7
	2025	3.5	88.9	0.4	5.5	1.7
Plantation	2005	3.2	60.8	0.1	4.7	31.3
crops	2015	3.1	60.9	0.1	5.1	30.8
	2025	3.1	60.5	0.1	5.4	30.8
Horticulture	2005	5.7	76.5	0.7	3.6	13.6
	2015	5.4	77.1	0.8	3.8	12.9
	2025	5.3	77.2	0.8	4.0	12.6
Milk	2005	3.5	80.4	0.6	14.7	0.9
	2015	3.4	79.7	0.6	15.4	0.8
	2025	3.3	78.9	0.7	16.3	0.8
Meat	2005	12.0	56.5	1.7	20.3	9.5
	2015	11.4	57.1	1.7	20.6	9.2
	2025	11.0	57.1	1.8	21.0	9.1
Eggs	2005	11.5	71.7	0.5	7.0	9.2
	2015	10.9	72.5	0.6	7.1	8.9
	2025	10.6	72.7	0.6	7.3	8.8
Livestock	2005	5.61	73.86	0.70	16.28	3.40
	2015	5.38	72.83	0.73	16.81	3.36
	2025	5.26	71.56	0.76	17.44	3.37
Fishries	2005	29.98	59.26	0.09	2.19	8.47
	2015	28.39	60.00	0.09	2.22	8.18
	2025	27.57	60.26	0.10	2.28	8.11
All Commodities	2005	10.73	73.34	0.57	7.27	7.95
	2015	10.38	72.70	0.60	7.79	7.63
	2025	10.24	71.83	0.63	8.32	7.49
Priority ratio (FBL/VOP)	2005	1.31	1.04	0.61	0.64	1.85
R&D allocaion	2002	6.37	79.15	1.52	9.99	2.98

countries will be helpful. The 'priority score' is the share of a commodity/group or country in 100 (per cent), and therefore, higher the score, higher is the priority. The national systems can use the priority matrix for allocation of resources across commodities. Fund facilitators can also use the priority matrix to track priority country and commodity or vice versa. Since identification of research priorities was the major objective of this exercise, we have focused on country and commodity priorities.

With the objectives of increasing productivity (VOP), increase in income of small farmers (poor), sustainable use of natural resources (land) and contribution to more exports (exports), independently and together, the top 3 priority countries are India, Pakistan and Bangladesh. The commodity priority scores (by country) and commodity groups are given in Tables 6.8, 6.9 and 6.10. It can be seen from these tables that the priority commodity groups in South Asia were cereals, horticulture, livestock and fishery and the priority commodities were rice and milk. In case of countries in the region, cereals topped the priority list in Bangaldesh and Nepal, horticulture topped the priority list in India and Sri Lanka, and livestock in Pakistan. In case of individual commodities, rice topped the list in Bangladesh, and Nepal, milk in India and Pakistan and plantation crops in Sri Lanka. The other important commodity/ies in different countries included rice in India, milk, meat and vegetables, in Nepal, rice and edible oils in Sri Lanka and meat and wheat in Pakistan. By and large, these priorities will continue up to 2025, with noticeable increase in priority of horticulture, livestock and fishery in both South Asia as well as countries in the region with the passage of time, 2015 and 2025. Shift in priority ratios by adjustment of VOP on the basis of growth in demand as stated earlier during 2015 and 2025 by commodities in different countries and South Asia as a whole suggested augmentation of research resources towards vegetables, fruits, milk, meat, eggs, and fish (Table 6.11). These priorities need to be kept in view while deciding the research agenda and research resource allocation and other needed development support. It is important to mention here that these results on commodity priorities are only indicative in nature and more degree of scientific judgement need to be applied to capture other relevant external factors and opportunities (including chances of research success) in setting research priorities at the microlevel (research programmes and projects).

Shift in Research Resources

An exercise was done to compare the existing resource allocation among commodity groups with the optimum level as per the identified priority score using the methodology described to find out the mismatch and needed changes. The existing level of resource allocation for South Asian countries was taken from ASTI datasets at www.asti.cgiar.org. The current research allocation information was not available for cereals and horticulture in Sri Lanka. The optimal and existing research allocations, presented in Tables 6.12 and 6.13, revealed that in case of cereals, the existing research allocations were less than optimal in Bangladesh and more than optimal in India, Nepal and Pakistan. In case of horticulture, it was more than optimal in Bangaldesh, India, and Pakistan, whereas it was less than optimal in Nepal. In case of livestock, it was less than optimal in all countries, except Sri Lanka. In case of fishery, it was less than optimal in case of Bangaldesh, India, and Sri Lanka, whereas in case of Nepal and Pakistan, it was more than optimal. How resources are to be shifted

Table 6.10: Shift in priority ratio among commodity groups in South Asia

Commodity	Year	Bangladesh	India	Nepal	Pakistan	Sri Lanka	South Asia
Rice	2005	1	1	1	1	1	1
	2015	0.95	0.91	0.95	0.95	0.91	0.92
	2025	0.91	0.85	0.91	0.91	0.85	0.86
Wheat	2005	1	1	1	1	1	1
	2015	0.96	0.90	0.93	0.93	0.91	
	2025	0.93	0.82	0.88	0.88	0.84	
Coarse cereals	2005	1	1	1	1	1	1
	2015	0.94	0.89	0.93	0.92	0.89	0.90
	2025	0.90	0.80	0.87	0.86	0.82	0.82
Cereals	**2005**	**1**	**1**	**1**	**1**	**1**	**1**
	2015	**0.95**	**0.90**	**0.94**	**0.93**	**0.91**	**0.91**
	2025	**0.91**	**0.83**	**0.89**	**0.88**	**0.85**	**0.85**
Pulses	**2005**	**1**	**1**	**1**	**1**	**1**	**1**
	2015	0.99	0.96	0.99	0.97	0.97	0.96
	2025	0.98	0.93	0.97	0.95	0.94	0.93
Edible oils	2005	1	1	1	1	1	1
	2015	0.99	0.95	0.97	0.97	0.95	0.96
	2025	0.97	0.91	0.95	0.95	0.91	0.92
Sweeteners	2005	1	1	1	1	1	1
	2015	0.98	0.94	0.96	0.96	0.94	0.95
	2025	0.95	0.89	0.93	0.92	0.90	0.90
Roots & tubers	2005	1	1	1	1	1	1
	2015	0.99	0.99	0.99	0.98	1.00	0.99
	2025	0.99	0.98	0.98	0.97	1.00	0.97
Vegetables	2005	1	1	1	1	1	1
	2015	1.03	1.07	1.04	1.02	1.08	1.06
	2025	1.05	1.12	1.06	1.04	1.14	1.10
Fruits	2005	1	1	1	1	1	1
	2015	1.05	1.07	1.05	1.04	1.04	1.07
	2025	1.09	1.13	1.09	1.08	1.07	1.12
Plantation	2005	1	1	1	1	1	1
crops	2015	0.99	0.99	0.99	0.98	1.00	0.99
	2025	0.99	0.98	0.98	0.97	1.00	0.97
Horticulture	**2005**	**1**	**1**	**1**	**1**	**1**	**1**
	2015	**1.01**	**1.04**	**1.02**	**1.01**	**1.02**	**1.03**
	2025	**1.02**	**1.07**	**1.04**	**1.02**	**1.02**	**1.05**
Milk	**2005**	**1**	**1**	**1**	**1**	**1**	**1**
	2015	1.04	1.05	1.04	1.02	1.06	1.05
	2025	1.07	1.08	1.07	1.04	1.12	1.09
Meat	2005	1	1	1	1	1	1
	2015	1.07	1.12	1.08	1.04	1.10	1.10
	2025	1.13	1.22	1.14	1.07	1.19	1.20
Eggs	2005	1	1	1	1	1	1
	2015	1.07	1.12	1.06	1.04	1.11	1.10
	2025	1.13	1.22	1.12	1.07	1.19	1.19
Livestock	**2005**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	2015	**1.06**	**1.06**	**1.06**	**1.03**	**1.10**	**1.07**
	2025	**1.10**	**1.11**	**1.10**	**1.05**	**1.18**	**1.12**
Fishries	**2005**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	2015	**1.07**	**1.12**	**1.07**	**1.04**	**1.10**	**1.09**
	2025	**1.13**	**1.22**	**1.13**	**1.07**	**1.19**	**1.17**

Table 6.11: Optimal allocation profile and adjustment cofficients, South Asia

Commodity	Year	Optimum shares (FBL)*	Priority ratio over 2005	Shift in existing resources
Rice	2015	16.2	0.92	**-8.3**
	2025	15.1	0.86	**-14.4**
Wheat	2015	6.8	0.91	**-9.1**
	2025	6.2	0.84	**-16.2**
Coarse cereals	2015	2.5	0.90	**-10.3**
	2025	2.3	0.82	**-18.3**
Cereals	**2015**	**25.4**	**0.91**	**-8.7**
	2025	**23.6**	**0.85**	**-15.3**
Pulses	2015	3.1	0.96	**-3.6**
	2025	3.0	0.93	**-7.1**
Edible oils	2015	8.3	0.96	**-4.5**
	2025	7.9	0.92	**-8.4**
Sweeteners	2015	3.0	0.95	**-5.1**
	2025	2.9	0.90	**-9.6**
Roots & tubers	2015	2.7	0.99	**-1.4**
	2025	2.7	0.97	**-2.8**
Vegetables	2015	7.9	1.06	**6.0**
	2025	8.2	1.10	**10.4**
Fruits	2015	7.8	1.07	**7.1**
	2025	8.2	1.12	**12.3**
Plantation	2015	8.1	0.99	**-1.4**
crops	2025	8.0	0.97	**-2.8**
Horticulture	**2015**	**26.6**	**1.03**	**3.1**
	2025	**27.2**	**1.05**	**5.3**
Milk	2015	17.7	1.05	**5.3**
	2025	18.4	1.09	**9.1**
Meat	2015	5.8	1.10	**10.4**
	2025	6.3	1.20	**19.5**
Eggs	2015	1.4	1.10	**10.4**
	2025	1.5	1.19	**19.2**
Livestock	**2015**	**24.9**	**1.07**	**6.7**
	2025	**26.1**	**1.12**	**12.0**
Fishries	2015	8.7	1.09	9.0
	2025	9.3	1.17	16.8

(FBL)* stands for final base-line

Table 6.12: Allocation of research resources in South Asia

(in per cent)

Commodity	Bangladesh	India	Nepal	Pakistan	Sri Lanka
Rice	20.6	14.7	25.2	6.8	
Wheat	6.8	6.3	19.1	16.1	
OCER	7.7	5.4	0	3.7	
Cereals	35.1	26.4	44.3	26.6	
Pulses	4.7	7.7	5.5	8.7	
Edible oils	7	10.6	7.2	10.1	
Sweeteners	5.7	5.5	2.4	8.1	
Roots & tubers	7.2	3.2	3.5	3.2	
Vegetables	8.9	6.8	7.5	6.9	
Fruits	13.2	9.2	4.5	12.5	
Plantation crops		**7.4**			
Horticulture	29.3	32.1	15.5	22.6	
Crop	81.8	76.8	74.9	76.1	81.5
Milk					
Meat					
Eggs					
Livestock	**8.1**	**17.6**	**19.1**	**19.6**	**10.6**
Fish	10.1	5.2	5.9	4.3	7.9
	100.0	100.0	100.0	100.0	100.0

Computed by using *Agricultural S&T Indicators* (ASTI) datasets at www.asti.cgiar.org

Table 6.13: Reallocation of research resources by commodity group in South Asia: 2005

Commodity	Bangladesh	India	Nepal	Pakistan	Sri Lanka
Cereals					
Optimal	**48.7**	**25.9**	**36.6**	**19.8**	**22.5**
Existing	35.1	26.4	44.3	26.6	na
Shift in existing resources (per cent)	38.6	-1.8	-17.4	-25.5	
Horticulture					
Optimal	**13.1**	**26.8**	**27.5**	**13.3**	**46.2**
Existing	29.3	32.1	15.5	22.6	na
Shift in existing resources (per cent)	-55.3	-16.7	77.2	-41.0	
Livestock					
Optimal	**12.3**	**23.6**	**28.8**	**52.5**	**10.0**
Existing	8.1	17.6	19.1	19.6	10.6
Shift in existing resources (per cent)	50.9	33.9	50.4	167.4	-5.2
Fishries					
Optimal	22.1	6.4	1.3	2.4	8.4
Existing	10.1	5.2	5.9	4.3	7.9
Shift in existing resources (per cent)	118.0	22.6	-78.8	-44.2	6.4

na: not available

keeping in view the optimal allocation has been shown in Table 6.13. There is a need to shift additional resources to Bangladesh for cereals. Nepal needs more resources for horticulture. Bangladesh, India and Sri Lanka require additional resource allocations for fisheries. Livestock will be priority for all the South Asian countries and they require substantial additional resource support.

A Case Study of Agricultural Research Prioritization in India with Focus on Poor

It is often observed that the current resource allocation is not in favour of the poor. Hence to assess what should be the priorities and how appropriate is the current allocation in relation to the needs of the poor, the case of India was taken. To develop the final base line, nutritional security (undernourished population) and social empowerment (non-food expenditure) were taken as modifiers. The IBL, impact, FBL and the priority index were worked out for very poor [75% below poverty line (PL)], poor (75% below to PL), non-poor low income (PL to 150% above PL) and non-poor high income (more than 150% above PL) categories. The priority index was the highest for very poor households (1.81), followed by poor (1.54), non-poor low income group (1.28). The results suggest that 81 % additional income is required to the very poor households to meet the objectives of nutritional security and social empowerment and similarly for other categories of poor households (Table 6.14).

Table 6.14: Final base line and modifier impact

Particulars	IBL	Impact	FBL	Priority index
Nutritional security				
Very poor	5.10	1.65	6.75	1.32
Poor	11.12	1.88	13.00	1.17
Non-poor Low income	27.09	0.72	27.81	1.03
Non-poor High income	56.69	-4.25	52.44	0.93
Social status				
Very poor	6.75	2.47	9.22	1.37
Poor	13.00	4.17	17.16	1.32
Non-poor Low income	27.81	6.91	34.72	1.25
Non-poor High income	52.44	-13.55	38.90	0.74
Total impact				
Very poor	5.10	4.12	9.22	1.81
Poor	11.12	6.04	17.16	1.54
Non-poor Low income	27.09	7.63	34.72	1.28
Non-poor High income	56.69	-17.80	38.90	0.69

IBL: Initial Base Line; FBL: Final Base Line
Value of commodities at constant price 2005
Very poor = Income 75% below poverty line
Poor = 75% below PL to PL
Non-poor Low income = PL to 150% above PL
Non-poor High income = more than 150% above PL

Table 6.15: Priority score of commodities by income groups, India: 2005, 2010 and 2015

Item	Household by income group				
	Very poor	Poor	Non-poor low income	Non poor high income	All groups
			Year 2005		
Rice	21.1	20.2	17.9	13.4	16.9
Wheat	13.3	12.7	10.9	8.1	10.4
OCER	6.1	5.1	4.6	2.2	3.9
Cereals	**40.5**	**38.1**	**33.4**	**23.8**	**31.1**
Pulses	6.5	6.3	5.9	5.2	5.8
Edible oils	9.5	9.3	8.6	7.8	8.5
Veg	14.6	14.4	13.5	12.2	13.2
Fruits	6.4	6.8	8.6	15.1	10.6
Horticulture	**21.0**	**21.2**	**22.1**	**27.2**	**23.8**
Sugar	7.0	6.5	6.3	5.8	6.2
Milk	8.2	10.6	14.7	19.4	15.2
Meat	4.3	4.7	5.2	6.8	5.7
Livestock	**12.6**	**15.3**	**19.8**	**26.2**	**20.9**
Fish	2.9	3.4	3.8	3.9	3.7
			Year 2010		
Rice	19.7	19.1	16.9	12.8	16.0
Wheat	12.5	12.2	10.7	8.1	10.1
OCER	5.3	4.6	4.2	2.1	3.6
Cereals	**37.6**	**35.8**	**31.8**	**23.0**	**29.7**
Pulses	6.6	6.4	5.9	5.1	5.8
Edible oils	9.9	9.6	8.7	7.7	8.6
Veg	15.1	14.7	13.6	12.1	13.4
Fruits	6.7	7.1	8.9	15.3	10.8
Horticulture	**21.8**	**21.8**	**22.4**	**27.4**	**24.2**
Sugar	6.9	6.4	6.2	5.7	6.1
Milk	9.0	11.3	15.5	19.9	15.8
Meat	4.9	5.1	5.5	7.1	6.0
Livestock	**13.9**	**16.4**	**21.0**	**27.0**	**21.8**
Fish	3.3	3.7	4.1	4.1	3.9
			Year 2015		
Rice	18.0	17.6	15.7	12.0	14.9
Wheat	11.4	11.5	10.2	8.0	9.7
OCER	4.5	4.0	3.7	1.9	3.2
Cereals	**33.9**	**33.0**	**29.6**	**21.9**	**27.8**
Pulses	6.8	6.4	5.8	5.0	5.7
Edible oils	10.4	9.8	8.8	7.7	8.7
Veg	15.7	15.0	13.7	12.0	13.5
Fruits	7.1	7.5	9.2	15.6	11.0
Horticulture	**22.8**	**22.4**	**22.9**	**27.6**	**24.5**
Sugar	6.8	6.2	5.9	5.5	5.9
Milk	9.9	12.3	16.5	20.4	16.5
Meat	5.7	5.7	6.0	7.5	6.5
Livestock	**15.6**	**18.0**	**22.5**	**28.0**	**23.0**
Fish	3.8	4.1	4.4	4.3	4.3

OCER = Other cereals

Further, priority score of commodities by income groups for the years 2005, 2015 and 2025 revealed that the staple food (cereals) is the top priority for the poor (Table 6.15). For example, for all groups in case of cereals, priority score is 31 but in case of very poor category it is 41 and in case of non-poor high (rich) it is only 24. Thus, it becomes very clear that cereals will be top priority for the poor. At present, resource allocation is not in favour of poor. Very poor and poor together should receive more than 50% additional income to remain optimal towards nutritional security (food expenditure) and social empowerment (non-food expenditure) to avail education, housing, transport and affordable nutritious food. With the raise of income, the priorities of the poor will also shift towards horticulture, livestock and fish.

Augmentation of Research Resources to Make South Asia Food Secured

To attain the food security by meeting the projected demand during different years in future up to 2025, it is important to estimate the required investment in R&D in South Asian countries. The current (2002) level of R&D investment (at 2005 international dollar) is provided in the publication by Beintema and Stads (2008). Based on review of TFP studies pertaining to South Asian countries (Birthal *et al*., 1999; Joshi *et al*., 2003; Kumar *et al*., 2004; 2008; Pasha *et al*., 2002), the share of TFP in total production varies across commodities and ranges from 5 to 30 per cent. It was low for cereals and high for horticulture,

Table 6.16: Required investment in research to attain food security in South Asia

Commodity	Share of TFP in total production (%)	Elasticity of TFP with resepect to research investment	Average food demand growth (%)	Elasticity of research investment with respect to supply	Required growth in research investment to attain one percent growth in food supply
Rice	10 to 20	0.05-0.10	1.24	1.24-1.60	1.00-1.29
Wheat	10 to 20	0.05-0.10	1.28	1.28-1.40	1.00-1.10
Coarse cereals	05 to 10	0.05-0.10	0.98	0.98-1.96	1.00-1.99
Pulses	05 to 10	0.05-0.10	1.76	0.98-1.97	0.56-1.12
Edible oils	20 to 30	0.05-0.07	1.76	1.76-3.53	1.00-2.01
Sweeteners	20 to 30	0.05-0.07	1.60	1.07-1.60	0.67-1.00
R&T	10 to 20	0.05-0.15	2.00	1.34-2.00	0.67-1.00
Vegetables	20 to 30	0.05-0.10	2.74	1.37-1.82	0.50-0.67
Fruits	20 to 30	0.05-0.15	2.83	0.94-1.41	0.33-0.50
Plantation & crops others	20 to 30	0.05-0.10	2.00	1.00-1.34	0.50-0.67
Milk	20 to 30	0.05-0.10	2.68	1.34-1.79	0.50-0.67
Meat	20 to 30	0.05-0.10	3.19	1.59-2.12	0.50-0.67
Eggs	20 to 30	0.05-0.10	3.16	1.58-2.11	0.50-0.67
Fish	20 to 30	0.05-0.10	3.08	1.54-2.06	0.50-0.67
All commodities	05 to 30	0.05-0.15	2.14	1.30-1.87	0.61-0.87

Table 6.17: Required investment in R&D to attain food security and reduce poverty and hunger in South Asia

(million International US dollar at 2005 price)

Country	Current investment 2002*	2010	2015	2020	2025
Scenario 1:	**2.14% agricultural growth (to attain national food security)**				
Bangladesh	109	126.4	138.7	152.1	166.9
India	1355	1571.5	1724.0	1891.4	2074.9
Nepal	26	30.2	33.1	36.3	39.8
Pakistan	171	198.3	217.6	238.7	261.9
Sri Lanka	51	59.1	64.9	71.2	78.1
South Asia	1712	1985.5	2178.2	2389.7	2621.6
Scenario 2:	**4% agricultural growth (to attain household food security and alleviation of poverty and hunger)**				
Bangladesh	109	143.3	170.0	201.8	239.4
India	1355	1781.5	2113.8	2508.2	2976.0
Nepal	26	34.2	40.6	48.1	57.1
Pakistan	171	224.8	266.8	316.5	375.6
Sri Lanka	51	67.1	79.6	94.4	112.0
South Asia	1712	2250.9	2670.8	3169.0	3760.1

livestock and fisheries. The elasticity of TFP with respect to research investment ranges from 0.05 to 0.15 as reported in various studies. Using these parameters, elasticity of research investment with respect to food supply (production) is estimated for all the commodities and used to suggest the required growth in research investment needed to maintain one per cent growth in food supply in future (Table 6.16).

The research investment is projected under two scenarios: (i) existing growth in food supply (2.14 percent) to meet the national food security, and (ii) target growth of 4 percent to meet the challenge of hunger and poverty in South Asia. The results revealed that at current annual growth rate of food supply (2.14 percent), the resource funding has to be increased to 2390 million US dollars from the current 1712 million USD by 2020 in South Asia. If we target 4% growth rate, then it has to be raised to 3169 million USD (Table 6.17) by the year 2020. Four percent growth in agricultural GDP can only be attained with greater emphasis on the development of livestock, horticulture and fishery sectors. This will generate the additional income to the small and marginal farmers and reduce poverty and undernourishment and shall contribute to social empowerment. The results relating to required investment at current price are indicated in Table 6.18. It can be seen that investment has to be nearly doubled at constant prices and tripled at current prices.

Table 6.18: Required research investment in R&D to attain food security and reduce poverty and hunger in South Asia

(current price in million US dollar)

Country	2002	2010	2015	2020	2025
Scenario 1:	**2.14% agricultural growth (to attain national food security)**				
Bangladesh	101.2	143.0	177.5	220.3	273.5
India	1258.3	1778.0	2206.9	2739.3	3400.0
Nepal	24.1	34.2	42.4	52.6	65.2
Pakistan	158.8	224.4	278.5	345.7	429.2
Sri Lanka	47.4	66.9	83.1	103.1	128.0
South Asia	1589.8	2246.4	2788.3	3461.0	4295.8
Scenario 2:	**4% agricultural growth (to attain household food security and alleviation of poverty and hunger)**				
Bangladesh	101.2	162.1	217.6	292.3	392.3
India	1258.3	2015.6	2705.8	3632.6	4876.5
Nepal	24.1	38.7	52.0	69.7	93.6
Pakistan	158.8	254.3	341.5	458.4	615.5
Sri Lanka	47.4	75.9	101.9	136.7	183.5
South Asia	1589.8	2546.7	3418.8	4589.7	6161.4