

Prioritization of Research for Horticultural Crops



March 2010

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First print : March 2010

Not for sale

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Correct citation :

Siddique, M.A. and A.K. Azad. 2010. Prioritization of Research for Horticultural Crops. Final Report of a Study, BARC, New Airport Road, Dhaka. 56 p.

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*A sub-sector report for the preparation of a document on
“**Agricultural Research Vision 2030 and Beyond**”*

(Final Report)

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March 2010

Funded by

Bangladesh Agricultural Research Council (BARC)

New Airport Road, Farm Gate, Dhaka

Prioritization of Research for Horticultural Crops

*A sub-sector report for the preparation of a document on
“Agricultural Research Vision 2030 and Beyond”*

Horticultural Crops Group

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1.Executive summary

This final report, entitled “Prioritization of Research for Horticultural Crops”, is a Sub-Sector study report leading to preparation of a document on “Agricultural Research Vision 2030 and Beyond”. The Bangladesh Agricultural Research Council (BARC) launched a program in October 2009 through constituting Expert Teams for carrying out research prioritization study on 12 Sub-Sectors of Agriculture. Each Team comprised a Team Leader and a Member Secretary. Prof. Dr. Md. Abdus Siddique of BAU and Dr. Abul Kalam Azad of BARC were assigned to work as the Team Leader and Member-Secretary, respectively, for the Horticultural Crops Sub-Sector. As per the ToR of the Team/Group Leaders, the “Horticultural Crops” Sub-sector included (a) fruits, (b) vegetables, (c) roots & tubers, (d) spices and (e) flowers & ornamentals for the study.

The activities performed by the Horticultural Crops Group include, (i) sending of request letter to resource persons of concerned institutes / organizations inviting suggestions on research needs in the field of horticulture, (ii) co-opting 4 members in the Group, (iii) search of literature and relevant documents, (iv) personal interviews with the concerned resource persons of BARI and BAU, (v) group consultation meetings at BAU and BARC, (vi) consideration of the findings of 4 regional workshops, (vii) presentation of the draft report in the workshop organized by BARC and (viii) finalization of the report.

Through personal interviews with the resource persons and group consultation meetings, the following 5 most urgent, important and result-oriented *thematic areas* (Research Agenda) were selected for the study:

1. *Variety development and conservation of plant genetic resources*
2. *Production technology*
3. *Seed and quality planting material*
4. *Post-harvest management*
5. *Agri-business in horticulture*

As a background information, the present report includes the past and present status and importance of the horticultural crops sub-sector in general, and of the sub-areas, namely, (i) fruits, (ii) vegetables, (iii) roots & tubers, (iv) spices and (v) flowers & ornamentals, in particular.

The horticulture sub-sector, comprising fruits, vegetables, roots & tubers, spices and flowers & ornamentals, covers a huge number of crop species. Many of those crops are of major importance, while most are of minor importance. There is a wide variation among the horticultural crops in respect of morphological features, growth habit, area under cultivation, total production and use. Horticultural research in Bangladesh should therefore be emphasized particularly on crops having economic and / or nutritional importance. Scope for commercial production, processing and export are the other considerations. It was therefore important to prioritize horticultural crops for carrying out research .under the selected 5 thematic areas. A list of priority

crops under fruits, vegetables, roots & tubers, spices and flowers & ornamentals has been presented in the report.

The research priorities for the sub-areas, (i) fruits, (ii) vegetables, (iii) roots & tubers, (iv) spices and (v) flowers & ornamentals have been presented in the report in 25 tables. There are 5 tables for each sub-area, 1 for each of the above-mentioned 5 selected thematic areas. Each table contains, **problems / constraints, brief research title, probability of success, priority ranking** and **research tenure**. The listed research priorities were formulated considering the present status, importance and future potentials of the crops; opinion of the experts / resource persons obtained through personal interviews and correspondences; suggestions of the participants of Group Consultation Meetings; recommendations of the Regional Workshops, suggestions obtained from the participants of BARC organized Crop Report Presentation Workshop and information available in the relevant publications and documents.

The draft report, submitted earlier, was presented in the Crop Report Presentation Workshop held at the BARC Conference Room on 08/03/2010 in presence of senior level officials / resource persons of BARC, BARI, BIRRI, BAU, BSMRAU, SAU, KGF, DAE, DAM, BADC and BINA.

The final report was prepared considering the suggestions of the resource persons and participants of the group consultation meetings, feedback of the regional workshops and suggestions for improvement and modification of the draft report obtained from the participants of BARC organized workshop held on 08/03/2010, In addition to the contents of the Draft Report, an **Executive Summary, ToR of the Group Leaders** and new paragraphs on **Prioritization of Crops for Horticultural Research, Constraints & Limitations** and **Conclusions & Recommendations** have been presented in the Final Report.

2. Launching of the program

The Bangladesh Agricultural Research Council (BARC) had undertaken an initiative for the preparation of a document on "**Agricultural Research Vision 2040 and Beyond**". In October 2009, In order to implement the program, BARC constituted 12 Expert Teams, with a Team Leader and a Member-Secretary / Rapporteur for each of the Teams. The teams were responsible for carrying out research prioritization study on 12 sub-sectors of agriculture. For the "**Horticultural Crops**" sub-sector, Dr. Md. Abdus Siddique of BAU and Dr. Abul Kalam Azad of BARC were assigned to work as the Team Leader and Member-Secretary / Rapporteur, respectively.

An orientation workshop for the Team Leaders and Member-Secretaries of the 12 sub-sectors were held at BARC on 25 October 2009. The aims and objectives of the sub-sector studies, ToR of the Team Leaders (Group Leaders) and guidelines of the group works were presented and discussed in

the workshop. It was agreed that, under the revised ideas, a “**Vision Document – 2030 and Beyond**” would now be prepared instead of “Vision Document – 2040 and Beyond”. As per the ToR of the Group Leaders, the “Horticultural Crops” Sub-sector was supposed to include (a) fruits, (b) vegetables, (c) roots & tubers, (d) spices and (e) flowers & ornamentals in the study.

3. Terms of reference (ToR) of the group leaders

i) Consultation and review of the documents related to agriculture and rural development. These are, but not limited to the followings. To accomplish the task the team may need to visit the concerned institutes.

- Planning Commission Reports on five year plan, annual budgetary documents etc.
- National Agriculture Policy
- Poverty Reduction Strategy of the GoB
- World Bank document on revitalizing agriculture and related others
- Agricultural sector review /Actionable policy briefs of the FAO
- Reports of the DFID, DANIDA and others on the performance of the agriculture sector in Bangladesh
- National Food policy
- National land use policy
- National livestock Policy
- National Fisheries Policy
- National Forestry Policy
- Vision document –2020 of BARC and Strategic plan of 1996
- Land, Soil and management of natural resources
- Reports on Food Security, quality and Safety
- Reports on MDG
- Master Plan & Annual Reports of ARIs
- Websites of various agencies

(**Source:** BARC Library, P & E Division, BARC, Concerned Institutes, Websites of the concerned Ministry/Organization)

Through collection and collation of the information as stated in Sl.-i, work out the countries situation / issues by the sub-sector of agriculture. These are;

- a.Rice
- b.Cereals other than Rice, Sugarcane and Jute
- c.Horticultural crops (Potato, Fruits, Vegetables, Spices, Flowers)
- d.Pulses and Oilseeds
- e.Soil and fertility management
- f.Forestry
- g.Livestock
- h.Fisheries
- i.Agricultural mechanization and water management
- j.ICT in agriculture
- k.Agricultural economics, marketing and supply chain development
- l.Technology development, agro-processing post-harvest technology, food quality and human nutrition

ii) Sub-sectoral studies are expected to be in-depth and detailed in nature. This to cover all component's current trend in production, demand-supply and gap, opportunities, problems and constraints, required technological interventions and their analysis in the country's context. By the process determine the priority need of the concerned sector/area by the year 2040 and beyond.

iii) Population dynamics, reduction in land resource base and degradation, issues pertaining to climate change & sea level rise (SLR), economics of commodity and non-commodity related activities, income growth rate etc. all these to be taken into account in formulating the research priority.

iv) Undertake other related tasks as may be deemed necessary or evolved while performing this assignment

v) Draft report of the teams to be presented in workshops to be organized by the Planning & Evaluation Division of BARC at suitable dates.

vi) Draft final report incorporating the comments / opinion obtained from the workshops, different agencies/individuals to be submitted within 2 (Two) months from the date of assignment to the MD (P & E), Bangladesh Agriculture Research Council, Dhaka.

4. Activities performed by the horticultural crops group

4a. Sending of request letter inviting suggestions : Immediately after receiving the BARC Executive Chairman's letter of 14/10/2009 concerning formation of Groups, the Leader of the Horticultural Crops Group sent a request letter to the concerned horticulturists and relevant personnel of BARI, DAE, Agricultural Universities, BADC, BARC, Donor-funded Projects and some private sector organizations on 20/10/2009 for sending a list of research needs (in order of priority) to him in the areas of crop improvement, crop adaptation to climate change, biotechnology, coastal agriculture, propagation techniques, hill agriculture and disease and pest management of horticultural crops.

4b. Meetings at BARI, Joydebpur : With a clear guideline obtained from the orientation workshop held on 25/10/009, the Group Leader and the Member-Secretary visited BARI, Joydebpur on 4/11/2009, and conducted a discussion meeting at HRC Building. The Director of HRC, Dr. Abdul Hoque and senior level scientific personnel of HRC and SRC of Joydebpur campus were present in the meeting. The views and suggestions of the participants, in respect of prioritization of research for fruits, vegetables, flowers and ornamentals and spice crops, were noted. On the same day, a meeting with the scientific personnel of TCRC was held at the TCRC building in presence of the Director of the Centre, Dr. Md. Ihsanul Huq. A similar meeting was also

held at the Biotechnology Division of BARI. Finally, the Group Leader and the Member-Secretary paid a visit to the Director General of BARI in his office, and discussed with him the relevant issues.

4c. Co-opting members in the Group : In accordance with the provisions of the project, the Horticultural Crops Group co-opted 4 members in the Group. The Director of HRC, Director of TCRC and Director of SRC were consulted in the process. The co-opted Members are –

1. Dr. Md. Abdul Hoque, Director, HRC
2. Dr. Mohammad Hossain, CSO, TCRC
3. Dr. Md. Azizur Rahman, Professor of Horticulture, BAU
4. Mr. Md. Masudul Hoque Jhontu, SSO, SRC, BARI, Shibganj, Bogra

4d. Individual meetings with BAU personnel : According to a prior set program, the Group Leader, Dr. Md. Abdus Siddique and a Member of the Group, Dr. Md. Azizur Rahman discussed with the following personnel of BAU individually on 9/11/2009 :

1. Dr. Md. Habibur Rahman, Head, Department of Horticulture
2. Dr. A.M. Farooque, Professor of Horticulture, BAU
3. Dr. Md. Ferdous Mondal, Professor of Horticulture, BAU
4. Mr. Md. Shahidul Hoque Choudhury, Professor of Horticulture, BAU
5. Dr. Md. Abdur Rahim, Professor of Horticulture, BAU
6. Dr. Md. Golam Rabbani, Professor of Horticulture, BAU
7. Dr. Md. Azizur Rahman, Professor of Horticulture, BAU
8. Dr. Md. Kamrul Hassan, Associate Professor of Horticulture, BAU
9. Dr. Md. Abdul Halim Khan, Professor of Crop Botany, BAU
10. Dr. Md. Mohsin Ali Sarder, Professor of Entomology, BAU
11. Dr. Bahadur Meah, Professor of Plant Pathology, BAU
12. Dr. Md. Abdul Baten, Professor of Environmental Science, BAU

4e. Group consultation meeting at BAU : Based on the outcome of the individual meetings, a group consultation meeting was organized in the Department of Horticulture of BAU on 16/11/2009. The meeting was chaired by the Dean of the Faculty of Agriculture, Prof. Dr. Mohammad Abdul Karim. In total 15 participants attended the meeting. The Member-Secretary of the Group, Dr. Abul Kalam Azad explained the purpose of the meeting, and thanked the participants for kindly attending the meeting. The Team Leader highlighted the important areas of horticulture which deserve priority in research. It was noted that, under the present system there is a serious problem in integrating the research conducted at the agricultural universities with the national agricultural research system; and it was identified as an important hindrance in the overall development of horticulture in Bangladesh. The Team Leader then presented the following list of research agenda (theme) for discussion:

- a) Crop improvement
- b) Crop adaptation to climate change
- c) Biotechnological approaches in horticulture
- d) Coastal horticulture
- e) Hill horticulture

- f) Propagation technique
- g) Disease and pest management
- h) Nutritional and market quality
- i) Improvement of production technology
- j) Post-harvest handling
- k) Homestead horticulture
- l) Export oriented production
- m) Processing oriented production
- n) Production of planting material
- o) Year-round and off-season production
- p) High tech production (*poly-tunnel, nutrient film, hydroponics, organic farming*)
- q) Food safety (*pesticide residual, microbiological, ripening & preservative chemicals*)
- r) Commercialization & value addition
- s) Socio-economic and technology adaptation study

Through detailed discussion, the following 5 most urgent, important and result-oriented **themes** (Research Agenda / Thematic Area) were selected :

1. *Variety development and conservation of plant genetic resources*
2. *Production technology*
3. *Seed and quality planting material*
4. *Post-harvest management*
5. *Agri-business in horticulture*

The Chairman of the meeting, Dr. M.A. Karim emphasized the need of preparing the “**Agricultural Research Vision 2030 and Beyond**” document initiated by BARC, and thanked the participants of the meeting for making a remarkable contribution in the process.

4f. Group consultation meeting at BARC: The Horticultural Crops Group organized another consultation meeting at BARC on 24/11/2009. The meeting was chaired by the former DG of BARI, Dr. Md. Mamunur Rashid, and participated by 16 resource persons from BADC, Action for Enterprise, Plant Breeding Division of BARI, HRC of BARI, Biotechnology Division of BARI, TCRC of BARI, Research Wing of BARI, BSMRAU, SRC of BARI, BAU, DAE and BARC, as listed below :

1. Dr. Md. Mamunur Rashid, Former DG, BARI
2. Dr. Md. Abdul Hoque, Director, HRC, BARI, Joydebpur
3. Mr. Md. A. Samad, GM (Hort), BADC, Dhaka
4. Dr. Meer Musharraf Hussain, Sr. Consultant, Action for Enterprise, Dhaka
5. Dr. Md. Harunur Rashid, Head, Plant Breeding Dvn., BARI, Joydebpur
6. Dr. A.K.M. Matiar Rahman, CSO (Veg), HRC, BARI, Joydebpur
7. Dr. Md. Al-Amin, PSO, Biotechnology Dvn., BARI, Joydebpur
8. Dr. Mohammad Hossain, CSO, TCRC, BARI, Joydebpur
9. Dr. Md. Jahangir Hossain, PSO, Research Wing, BARI, Joydebpur
10. Dr. Md. Zakaria, Asst. Professor of Hort., BSMRAU, Shalna, Gazipur
11. Mr. Md. Masudul Haque Jhontu, SSO, SRC, BARI, Shibganj, Bogra
12. Dr. Md. Azizur Rahman, Professor of Hort., BAU, Mymensingh
13. Mr. Md. Abdul Quddus, Director, Food Crop Wing, DAE, Khamarbari, Dhaka
14. Dr. Md. Abdus Salam, PSO (P&E), BARC, Dhaka
15. Dr. Abul Kalam Azad, CSO (Crops) A/C, BARC, Dhaka
16. Dr. Md. Abdus Siddique, Professor of Hort., BAU, Mymensingh

The Member-Secretary of the Group, Dr. Abul Kalam Azad welcomed the participants and presented a brief report of the progress made. The Team Leader, Dr. Md. Abdus Siddique opened the discussion with a presentation of the research needs in horticulture and thematic areas of research. The participants agreed with the identified 5 thematic areas selected earlier in a consultation meeting held at BAU. The participants took part in the discussion on research needs under each thematic area. Dr. Md. Azizur Rahman, in a short presentation, demonstrated the present status and future potential of some horticultural crops. The representatives of BADC, DAE and BSMRAU emphasized the need of research on farmer-based problems. The Chairman of the meeting, Dr. Md. Mamunur Rashid thanked the participants for making a significant contribution in the process of prioritization of research for horticultural crops. He indicated that the research should be demand based and aiming to national and international benefits. According to Dr. Rashid, no research on floriculture has yet been started in Bangladesh, and that there is a tremendous scope for research in the area (Rashid, 2010). However, according to him, foreign training, manpower development and donor support are needed for effective research in ornamental horticulture.

4g. Consideration of regional workshop feedback: In order to take into account the agricultural problems currently prevailing at the field level, a Workshop on “Identification and Prioritization of Researchable Agricultural Problems” was organized by BARC at 4 locations (Bogra, Chittagong, Barisal, Mymensingh) during December 2009 to February 2010. The recorded findings / observations were made available to all Group Leaders. The Horticultural Crops Group has duly considered the findings of the regional Workshops in preparing the draft / final report of the Sub-Sector.

4h. Presentation of draft report in the workshop organized by BARC: The draft report on Prioritization of Research for Horticultural Crops, submitted to the MD (P&E), BARC on 03/01/2010, was presented in a Workshop held at the BARC Conference Room on 08/03/2010. Draft reports of 3 other Sub-Sectors, namely, (i) Rice, (ii) Cereals other than Rice + Sugarcane + Jute and (iii) Pulses and Oilseeds were also presented in the Workshop by the respective Group Leaders. Senior level officials / resource persons of BARC, BARI, BRRI, BAU, BSMRAU, SAU, KGF, DAE, DAM, BADC and BINA were present in the Workshop. Among the invited horticultural experts / resource persons, the following personnel were present:

1. Dr. S. M. Monwar Hossain, Managing Director, Hortex Foundation
2. Dr. Md. Abdul Hoque, Director, HRC, BARI
3. Dr. Dr. Md. Azizur Rahman, Professor of Horticulture, BAU
4. Dr. Md. Abdus Siddique, Professor of Horticulture, BAU & Group Leader
5. Dr. Abul Kalam Azad, CSO (Crops), BARC & Member-Secretary

The improvements / modifications suggested by the participants were recorded by the respective Member-Secretaries and Group Leaders. The Group Leaders were requested to submit the Final Reports with due consideration of the suggested improvements.

4i. Preparation and submission of final report : The final report was prepared considering the suggestions for improvement and modification obtained from the participants of BARC organized workshop held on 08/03/2010. The comments and suggestions of the resource persons and participants of the group consultation meetings and feedback obtained from the regional workshops were also considered in finalizing the report. In the final report an Executive Summary, ToR of the Group Leader and notes on Prioritization of Crops for Horticultural Research, Constraints & Limitations and Conclusions & Recommendations have been included. Necessary correction and improvement in the text of the draft report have also been made.

5. Present status and importance of the horticultural crops sub-sector

In general, horticultural crops include fruits, vegetables, ornamentals and spices. However, disregarding some controversies, plantation crops and medicinal plants are also considered as horticultural crops. Crops like, potatoes, sweet potatoes, aroids and yams are the staple food crops in some countries, but are considered as horticultural crops in Bangladesh.

Horticultural crops, although comprise some most important food and cash crops, are grown in a very small portion of the total cultivated land of Bangladesh. As for example, fruits covered only about 0.98 % and vegetables covered 2.18 % of the total cultivated area in 2005-06 (Table 1). However, there had been a remarkable increase in total production of fruits, vegetables,

Table 1. Area under cultivation of different crops in Bangladesh (2005-06)

Crops	% Area under cultivation	Area (000 ha)
Rice	76.71	10534
Wheat	3.49	479
Pulses	2.46	337
Oil seeds	2.47	338
Sugarcane	1.11	153
Jute	2.93	402
Fruits	0.98	134
Vegetables	2.18	299
Spices & condiments	3.38	321
Potato	2.19	301
Others	2.10	288
Total	100 %	13586

Source : BBS, 2008

spices and potatoes in the country during the period from 2001-02 to 2007-08. Although there is a great irregularity and anomaly in BBS data on area, production and yield of horticultural crops, the same data have been used in this document for better understanding of the sub-sector. The increase in

total production during the period from 2001-02 to 2007-08 appears to be more prominent in fruits, potatoes and spices than in vegetables (Table 2).

Table 2. Production of different crops in Bangladesh during 2001-02 to 2007-08
(000 mt)

Crops	2001-2	2002-3	2003-4	2004-5	2005-6	2006-7	2007-8
Fruits	1557	1629	1774	4403	3171	3457	3431
Vegetables	1606	1606	1753	1880	1905	2047	2247
Spices	418	425	608	1000	1181	1406	1334
Potato	2994	3386	3907	4855	4161	5167	6648
S. Potato	346	332	320	311	308	304	307
Coconut	87	88	133	271	326	352	334

Source : BBS, 2009c

For the purpose of the present study, horticultural crops will include **(a)** Fruits, **(b)** Vegetables, **(c)** Roots and tubers, **(d)** Spices and **(e)** Flowers and ornamentals. The current status and importance of the stated groups of horticultural crops have been presented below.

5a. Fruits

While mentioning self-sufficiency in food, the nutritional aspects are often not duly recognized. Although the production of grains has reached to 'near self-sufficiency' in Bangladesh, the production of fruits and vegetables is still far behind of our requirements. Fruits are generally rich in vitamins and minerals, and are essential items of a balanced diet. Fruits are grown in about 134 thousand hectares of land in Bangladesh comprising only about 0.98 % of the total area under cultivation (Table 1).

The BBS data on fruit production are not clear and free from confusions and controversies. The available BBS data indicate that about 4403 thousand tones of fruits were produced in the country during the year 2004-05, and there had been a fall thereafter (Table 2). Banana is the most important fruit crop of Bangladesh. Although the area and production of banana increased significantly during the period from 1971-72 to 2006-07, the per hectare yield remained almost static (Table 3). Among the other quick growing fruits, the area, production and yield of pineapple although increased significantly after 2001-02,

Table 3. Area, production and yield of quick growing fruits in Bangladesh (1971-2008)

Fruit Crops / Year	Area (000 ha)	Production(000 mt)	Yield (mt / ha)
Banana			
1971-72	38.0	586	15.42
1976-77	37.6	579	15.40
1981-82	42.5	686	16.14
1986-87	40.9	684	16.72
1991-92	39.2	625	15.94
1996-97	39.7	625	15.74
2001-02	44.9	654	14.56
2004-05	53.9	899	16.67
2005-06	56.0	909	16.23

2006-07	58.7	1005	17.10
2007-08	53.3	877	16.45
Pineapple			
1971-72	10.5	90	8.57
1976-77	14.6	142	9.73
1981-82	14.6	154	10.55
1986-87	12.9	145	11.24
1991-92	13.8	150	10.87
1996-97	13.8	148	10.72
2001-02	14.2	154	10.81
2004-05	18.5	235	12.70
2005-06	17.1	254	14.84
2006-07	17.0	238	14.00
2007-08	16.0	210	13.13
Papaya			
1971-72	2.4	19	7.92
1976-77	2.4	19	7.92
1981-82	3.2	26	8.13
1986-87	3.6	30	8.33
1991-92	4.0	30	7.50
1996-97	5.3	39	7.36
2001-02	6.9	48	6.98
2004-05	3.1	99	31.94
2005-06	1.1	105	95.66
2006-07	1.2	96	80.00
2007-08	-	104	-
Melon			
1971-72	6.1	96	15.74
1976-77	7.7	104	13.51
1981-82	7.7	101	13.12
1986-87	9.3	120	12.90
1991-92	12.1	110	9.09
1996-97	11.7	97	8.29
2001-02	10.5	85	8.17
2004-05	4.4	31	7.01
2005-06	4.4	41	9.32
2006-07	4.5	42	9.56
2007-08	-	-	-

Source : BBS, 2009c

remained almost similar during the recent years (2004-05 to 2007-08). In case of papaya, although the yield remained similar during the period from 1971-72 to 2001-02, there was an increase in production due to increase in area under cultivation. However, the data on area, production and yield of papaya during the period from 2004-05 to 2007-08 appear erratic (Table 3). There was a gradual increase in the area under cultivation of melon during 1971-72 to 1991-92, but the area and production decreased drastically after 2001-02.

The data on percentage of area under cultivation of different fruit crops in Bangladesh (Table 4) demonstrate that in the year 2005-06, banana occupied the highest area (42.2 %), followed by mango (19.6 %), pineapple (12.8 %) and jackfruit (7.0 %).

Table 4. Percentage of area under different fruit crops in Bangladesh (2005-06)

Fruit Crops	% Area under cultivation
Mango	19.57
Jackfruit	7.03
Guava	4.28
Litchi	1.28
Banana	42.20
Pineapple	12.84
Melon	3.36
Other fruits	9.44
Total	100 %

Source : BBS, 2008

The area and production trends of perennial fruit crops, namely, mango, jackfruit, litchi and guava show that during the period from 1971-72 to 2001-02, there was a little increase in the area under mango (established orchards + isolated trees) with a gradual fall in production due to decrease in yield (Table 5). But from 2004-05 to 2007-08, the area under mango (established orchards) increased with a significant increase in total production (established orchards + isolated trees). In case of jackfruit, both area and production increased during the period from 1971-72 to 2001-02 with no significant change in yield per unit area. However, during the period from 2004-05 to 2006-07, there was an increasing trend in area under jackfruit (orchards) with a significant increase in total production (orchards + isolated trees).

As in case of mango, there was an increasing trend in the area under litchi with a gradual decrease in yield during the period from 1971-72 to 2001-02. The total production of litchi did not change much, and remained in the range of 10-14 thousand tones per year during the period. However, the total production of litchi increased significantly during the period from 2004-05, reaching to 44 thousand tones in 2006-07. A remarkable increase in the annual production of guava was recorded during the last 3-4 decades, reaching from 7 thousand tones in 1971-72 to 152 thousand tones in 2006-07. Use of improved variety, quality planting material and increased area under cultivation contributed to such increase in production of guava.

Table 5. Area, production and yield of perennial fruit crops in Bangladesh (1971-2008)

Fruit crops / year	Area (000 ha)	Production (000 mt)	Yield (mt / ha)
Mango			
1971-72	40.9	360	8.80
1976-77	42.9	264	6.15
1981-82	45.3	181	4.00
1986-87	46.1	160	3.47
1991-92	49.0	183	3.73
1996-97	50.2	187	3.73
2001-02	50.6	187	3.70
2004-05	25.5*	662*	-
2005-06	26.0	640	-
2006-07	29.1	767	-
2007-08	31.6	803	-

Jackfruit			
1971-72	17.4	187	10.75
1976-77	19.0	203	10.68
1981-82	20.6	205	9.95
1986-87	23.5	254	10.81
1991-92	25.1	256	10.20
1996-97	26.3	265	10.08
2001-02	27.1	276	10.14
2004-05	7.4*	745*	-
2005-06	9.2	720	-
2006-07	10.0	926	-
Litchi			
1971-72	2.0	12.0	6.00
1976-77	2.8	12.0	4.29
1981-82	3.2	12.0	3.75
1986-87	3.6	10.0	2.78
1991-92	4.0	11.0	2.75
1996-97	4.9	13.0	2.65
2001-02	5.3	14.0	2.64
2004-05	1.8*	23.0*	-
2005-06	1.7	40.0	-
2006-07	1.6	44.0	-
Guava			
1971-72	1.6	7.0	4.38
1976-77	2.0	8.0	4.00
1981-82	2.4	10.0	4.17
1986-87	4.0	14.0	3.50
1991-92	5.3	25.0	4.72
1996-97	9.3	44.0	4.73
2001-02	10.1	50.0	4.95
2004-05	6.1*	59.2*	-
2005-06	5.8	144.5	-
2006-07	5.7	152.0	-

*From 2004-05, the area was recorded only from orchards (established gardens), but the production was recorded both from orchards / gardens and isolated plants

Source : BBS, 2009c

The change in area under cultivation and production of different fruits in Bangladesh (increase or decrease) during the period from 1984-85 to 2007-08 varied widely among the fruit crops. The increase in area was highest in guava showing an index of 486 in 2003-04 against the base of 100 in 1984-85 (Table 6).

Similarly, the increase in total production was highest in guava showing an index of 1128 in 2006-07 against the base of 100 in 1984-85. The other fruit crops showing high index values for production in 2007-08 were, jujube (1018), lime & lemon (837), mango (494) and jackfruit (441). Index values lower than 100 in the production of melon during the years 2003-04 to 2007-08 indicate decrease in production than in 1984-85.

Table 6. Indices of area and production of different fruit crops*(Base : 1984-85 = 100)*

Fruit	Area*					Production				
	03-4	04-5	05-6	06-7	07-8	03-4	04-5	05-6	06-7	07-8
Banana	122	133	138	145	145	102	130	132	145	127
Mango	113	55	57	64	70	149	407	303	471	494
Pineapple	126	139	129	127	-	162	178	193	181	-
Jackfruit	124	33	41	46	45	126	788	712	418	441
Papaya	231	94	34	-	59	186	362	386	-	380
Melon	112	45	45	48	-	72	25	33	35	29
Litchi	163	51	48	49	67	146	229	399	432	434
Jujube	279	55	47	18	19	335	260	1082	950	1018
Guava	486	177	169	161	174	599	1107	1084	1128	1127
Lime & lemon	291	81	88	89	77	289	535	726	598	837

*From 2004-05, the areas of mango, jackfruit, papaya, litchi, jujube, guava, lime and lemon were recorded only from established orchards / gardens; and the production was recorded both from orchards / gardens and isolated plants. *Source : BBS, 2008*

A daily consumption of 85 grams of fruits is recommended for a person (Bhuyan and Hossain, 2009). But the per head per day availability of locally produced fruits in 2007-08, with a total production of 3431 thousand tones in the year, was only 66 grams (BBS, 2009). The deficit thus was 22 %; which would be more if quantity used in processing and post-harvest spoilage were taken into consideration. However, it is difficult to estimate the per head per day consumption of fruits in Bangladesh, because of import and smuggling in of a huge quantity of fruits (mainly mango, orange, apple, pear and grapes) in to the country almost throughout the year. On the other hand, the locally produced fruits are not harvested equally round the year, and most of the local fruits come to the market during a particular season of the year (April-July). Again, the estimate of per head per day consumption of fruit is misleading for a country like Bangladesh, since the consumption of fruits is not equally distributed among the people of different socio-economic status. Fruits like, litchi, orange, apple, pear and grapes are generally consumed only by the people of high income group of this country.

Recent progresses in research and development of fruits in Bangladesh include, collection and evaluation of germplasm, development and release of improved varieties of major and minor fruits, standardization of propagation techniques, improvement in production technology, production and distribution of quality planting material and training of fruit growers and nurserymen (HRC, 2009). Involvement of HRC of BARI, Agricultural Universities, private sector organizations, NGOs and donor supported projects in the fruit research and development activities is well-recognized. Among the identified major constraints of the fruit industry of Bangladesh, insufficient improved varieties, irregular bearing habit of some fruits, seasonality in bearing and harvesting, inadequate supply of quality planting material, sub-optimal management practices, high post-harvest losses and inadequate disease and pest management are notable. There is a strong feeling of the senior horticulturists that fruit research should be directed to limited fruit crops rather than a large number of crops.

5b. Vegetables

Vegetables are the most important component of our food, and are rich in vitamins, minerals and fibers that are essential for human health. A number of vegetables are known to be as protective food items which prevent many diseases and ailments like, dislipidemia, cardiac disease, diabetes and constipation. Vegetables can be grown round the year, utilize homestead lands, provide high economic return and help in employment and income generation.

Although root and tuber crops, namely, potato, sweet potato, aroids and yams are considered as vegetables in Bangladesh, the status of those crops have been presented and discussed in the 'Roots and tubers' part of this document (3 c). Depending on growing season in Bangladesh, vegetables are classified as winter and summer vegetables. Among the winter vegetables, brinjal, pumpkin, cabbage, cauliflower, tomato, bottle gourd, radish, country bean and spinach are important ; and among the summer vegetables, pumpkin, brinjal, pointed gourd, lady's finger, ribbed gourd, snake gourd, bitter gourd, yard long bean, cucumber, ash gourd, amaranths and Indian spinach are important.

According to BBS data, brinjal (winter + summer) occupied the highest percentage of land under cultivation of vegetables in Bangladesh during the year 2005-06 (Table 7). However, a significant change in the area and production of different vegetables during the period from 1984-85 to 2007-08 was noticed. The index values for different vegetables in 2007-08 against the base value of 100 in 1984-85 indicate the change in area and production of the relevant vegetables during the period (Table 8). The index values show that the increase in area under cultivation was relatively higher in okra,

Table 7. Percentage of area under cultivation of different vegetable crops in Bangladesh (2005-06)

Vegetable Crops	% Area under cultivation
Brinjal	16.89
Pumpkin	6.76
Radish	8.38
Aroids	6.35
Tomato	6.22
Beans	4.73
Other vegetables	50.67
Total	100 %

Source : BBS, 2008

Table 8. Indices of area and production of different vegetable crops in Bangladesh.

Base : 1984-85 = 100

Crops	Area					Production				
	03-4	04-5	05-6	06-7	07-8	03-4	04-5	05-6	06-7	07-8
Brinjal-R	212	207	177	163	166	202	193	184	186	181
Brinjal-K	249	235	216	197	203	227	211	222	213	236
Pumkin-R	190	196	208	194	236	203	209	245	208	280
Pumkin-K	209	211	231	246	270	229	270	311	361	384
Caulifl.	167	176	202	205	212	168	181	229	230	259
Cabbage	169	180	196	202	215	202	223	276	286	331
Bottle G.	187	193	200	206	214	200	204	221	236	253
Tomato	188	186	197	203	206	167	171	183	191	200
Radish	145	151	155	157	171	160	269	174	179	202
Beans	199	207	228	246	248	193	199	241	272	272
Pointed G.	211	257	276	288	295	223	328	331	370	381
Okra	278	295	342	364	380	320	346	440	511	509
Ribbed G.	206	211	223	227	242	194	199	212	228	256
Bitter G.	199	218	234	237	256	200	258	253	268	309
Ash G.	115	125	158	198	236	129	141	184	226	268
Cucumber	214	211	243	257	275	220	213	248	284	321
Snake G.	183	205	247	278	296	164	200	260	270	298

Source : BBS, 2008

pointed gourd, snake gourd, cucumber and summer pumpkin; and the increase in total production was higher in okra, summer pumpkin, pointed gourd, cabbage and bitter gourd.

In the year 2007-08, nearly 2247 thousand metric tones of vegetables were produced in Bangladesh in about 302.6 thousand hectares of land (BBS, 2009b). It has been estimated that the per head consumption of vegetables in Bangladesh is about 44 g per day, which is much lower than that of our neighbouring countries (Table 9). Such a low rate of vegetable consumption in Bangladesh is particularly due to the traditional rice-based food habit

Table 9. Per capita consumption of vegetables in Bangladesh and neighbouring countries.

Country	Per head consumption	
	g / day	kg / year
Bangladesh	44	16
Thailand	258	94
India	229	84
China	292	107
Japan	433	158
Korea	684	250

Source : Rashid, 2009

of the people and high price of vegetables in the country. Considering the nutritional need of people, the daily requirement of vegetables for a person is 220 gram (Rashid, 2009). This suggests the need of about 11051 thousand

tones of vegetables in the country for the year 2010-11. Based on the projected population and daily requirement of vegetables for a person, a supply of about 13985 thousand tones of vegetables will be needed for the year 2031 (Table 10). Since, it would not be possible to increase the production of vegetables up to that level due to limitation of land and other

Table 10. Projected demand for vegetables in Bangladesh on the basis of projected population by the year 2030-31.

Indices	2006-07	2010-11	2020-21	2030-31
Population (million)	142.60	151.41	171.71	191.60
Production of vegetables (000 mt)	2047	2047*	2047*	2047*
Demand for vegetables based on nutritional requirement (000 mt)**	10408	11051	12533	13985
Production and demand gap for vegetables (000 mt)	8361	9004	10486	11938

*Considering the level of production same as of 2006-07; **Considering 220 g / head / day

practical reasons, efforts should be made to minimize the gap between the present level of production and demand through research efforts leading to increase in yield per unit area. As with all other crops, the well-recognized tools for increasing the yield per unit area are, use of improved varieties, high quality planting material and modern technology of production covering optimal soil management, plant density, plant nutrients, irrigation, disease management and pest control.

On the other hand, increased production of vegetables in Bangladesh often causes problems in marketing leading to drastic fall in price in the major growing areas; and such aspects also deserve due attention. Post-harvest management, processing and export potentials are the areas to be looked at.

5c. Roots and tubers

Roots and tubers include mainly potatoes, sweet potatoes, yams and aroids; and are mostly rich in carbohydrates. The edible parts of these crops are perishable and cannot be stored long under ordinary conditions. Many of the root and tuber crops, including potatoes, are considered as major food crops in many countries of the world, but are treated as vegetables in some other countries including Bangladesh. For giving special research thrust, the root and tuber crops were brought under the management of Potato Research Centre (PRC) of BARI. The Potato Research Centre was re-designated as the Tuber Crops Research Centre (TCRC) later. Potato is the most important crop in Bangladesh among the root and tuber crops. During the recent past, about 80 % of TCRC's research efforts was on potato, and about 70 % of the potato research was on variety development (Baset *et al.*, 2004). Potato research and development activities are also carried out at the agricultural universities (Hussain, 1992; Hossain, 2001; Hossain, 2003; Banik, 2005; Hossain, 2006;

Yasmin, 2006) , some private sector organizations and NGOs. Other than improvement of varieties, potato research in Bangladesh included research on true potato seeds (TPS), indigenous potato varieties (Siddique, 1995), traditional and tissue culture techniques of seed potato production, agronomic practices, diseases, insect pests and post-harvest management.

Recently potato has become an important food crop in Bangladesh, and has drawn special attention of the growers, traders, input suppliers, seed producers, processors, exporters, researchers, extension workers and policy level people of the country (Hussain, 2008; Rabbani *et al.*, 2009). There had been a remarkable increase in the area and production of potato in Bangladesh during the period from 1960-61 to 2008-09, with the highest production of 6648 thousand tones in an area of 402 thousand hectares of land in 2007-08.(Table 11). The per hectare yield of potato ranged between 6.1 to 10.1 tones during 1960-61 to 1990-91, and between 12.6 to 16.5 tones during 2000-01 to 2008-09. The gradual increase in area, total

Table 11. Area, production and yield of potato in Bangladesh during 1960-61 to 2008-09

Year	Area (000 ha)	Production (000 mt)	Yield (mt/ha)
1960-61	55.8	338.3	6.1
1970-71	86.6	849.3	9.8
1980-81	102.2	983.1	9.6
1990-91	127.5	1286.6	10.1
2000-01	249.0	3220.0	12.9
2001-02	237.7	2994.0	12.6
2002-03	245.0	3386.0	13.8
2003-04	270.9	3907.0	14.4
2004-05	326.3	4855.0	14.9
2005-06	300.8	4160.0	13.8
2006-07	344.9	5167.0	15.0
2007-08	402.0	6648.0	16.5
2008-09	395.6	5268.0	13.3

Source : BBS, 2009c

production and yield of potato in Bangladesh was contributed by several factors, namely, improvement of variety, supply of high quality seed potatoes, increase in the number of cold stores, participation of private sector organizations and commercial approach in production and marketing (Hussain, 2008; Hossain *et al.*, 2008; Ali and Haque, 2009; Rabbani *et al.*, 2009)

5d. Spices

Spices are non-leafy parts of plants, such as, buds, fruits, seeds, barks, rhizomes and bulbs, which are used as flavouring and seasoning agents in the preparation and processing of food items. The term 'herb' is used to categorize fresh plant parts used for the purpose same as spices, but derived from leaves or soft flowering parts. Asia is known to be the place of origin, production, consumption and export of most spices. Out of 109 plant species

grown as spices in the world, only 6 are considered as major spices produced in Bangladesh (Table 12).

Table 12. List of different spices as classified by SRC of BARI.

Major spices	Minor spices	Perennial spices	Other spices
i. Onion	i. Fenugreek	i. Bay leaf	i. Cumin
ii. Chilli	ii. Aniseed	ii. Black pepper	ii. Nutmeg
iii. Turmeric	iii. Fennel	iii. Cinnamon	iii. Vanilla
iv. Garlic	iv. Dill	iv. Cardamom	iv. Mint
v. Ginger	v. Dal Firingi	v. Clove	v. Juniper
vi. Coriander	vi. Black cumin	vi. Bose	vi. Saffron
	vii. Bilati Coriander		vii. Celery

The agro-ecological conditions of Bangladesh are congenial for the production of different spice crops, namely, onion, garlic, chilli, ginger, turmeric, coriander and fenugreek. Bangladesh produces about 1334 thousand tones of spices (Table 2) in about 321 thousand hectares of land. The land area covered by spice crops is about 3.38 % of the total cultivated land of the country (Table 1).

Among the major spice crops of Bangladesh, the area and production of onion, garlic, turmeric, ginger and coriander increased at different levels during the recent years, but the same of chilli demonstrated a decreasing trend (Table 13). However, the production of chilli, onion, garlic and ginger in Bangladesh increased 2 to 5 times during the last 3-4 decades (Table 14). A high value crop is one that returns a higher gross margin per unit of utilized resources (land, labour, capital and human capacities) than another crop under a given location and context; and according to the stated criterion, the spices can be considered as high value crops. The major problems which the spices produced in this country face in the local and foreign markets are, high price of the product as a result of high cost of production and poor quality of the finished product due to microbial infection and toxic chemical contamination. The existing post-harvest processing and storage practices, in most cases, are of sub-standard level.

Table 13. Production of major spices in Bangladesh during 2003-04 to 2007-08.

Spice Crops	2003-04	2004-05	2005-06	2006-07	2007-08
Chilli					
Area (000 ha)	162.2	154.8	142.5	141.3	93.5
Production (000 mt)	138	186	155	154	118
Yield (mt / ha)	0.86	1.20	1.09	1.09	1.26
Onion					
Area (000 ha)	62.0	86.4	115.6	128.7	125.1
Production (000 mt)	272	589	769	894	889
Yield (mt / ha)	5.24	6.82	6.65	6.94	7.11
Garlic					
Area (000 ha)	21.1	25.6	26.6	38.8	33.6
Production (000 mt)	73	90	102	177	145
Yield (mt / ha)	3.48	3.52	3.85	4.55	4.32

Turmeric					
Area (000 ha)	18.6	19.0	20.2	21.5	23.1
Production (000 mt)	71	79	92	110	130
Yield (mt / ha)	3.81	4.16	4.55	5.11	5.63
Ginger					
Area (000 ha)	7.9	7.7	8.0	8.5	9.3
Production (000 mt)	48	49	57	63	76
Yield (mt / ha)	6.09	6.42	7.10	7.41	8.17
Coriander					
Area (000 ha)	7.3	8.1	8.1	8.5	8.9
Production (000 mt)	5	6	6	7	7
Yield (mt / ha)	0.72	0.72	0.74	0.82	0.79

Source : BBS, 2009a ; BBS, 2009b

In the recent years, Bangladesh has been producing 1334 to 1406 thousand metric tones of spices per year against the annual requirement of about 2600 thousand tones; which indicates that there exists a gap of about 1194 to 1266 thousand tones between the demand and local production. The estimated demand is, however, on the basis of local domestic consumption. The gap is met through official import and smuggling in of spices, mostly from the neighbouring countries. Bangladesh Bank data show that the cost for the import of 5 major spices (onion, garlic, chilli, ginger and turmeric) in the year 2006-07 was Tk. 610.8 crore ; of which 70.2 % was for onion, 20.0 % for garlic, 0.6 % for chilli, 7.0 % for ginger and 2.2 % for turmeric (Bangladesh Bank, 2007). The total production of 6 major spices in Bangladesh during the year 2006-07 was 1406 metric tones (Table 2), and the population in July 2007 was 142.6 million. Taking the projected population under consideration, the demand for 6 major spices would be around 3493 thousand metric tones in the year 2030-31 (Table 15).

Table 14. Production of major spices in Bangladesh during 1971-72 to 2007-08.

Spice Crops / Year	Area (000 ha)	Production (000 mt)	Yield (mt / ha)
Chilli			
1971-72	82.1	58.1	0.71
1976-77	77.1	44.7	0.58
1981-82	75.6	45.0	0.60
1986-87	66.4	43.0	0.65
1991-92	67.6	51.0	0.75
1996-97	66.4	53.0	0.80
2001-02	170.0	136.0	0.80
2004-05	154.8	185.6	1.20
2005-06	142.5	155.0	1.09
2006-07	141.3	154.0	1.09
2007-08	93.5	118.0	1.26
Onion			
1971-72	33.2	157.0	4.73
1976-77	32.0	136.0	4.25
1981-82	33.6	132.0	3.93
1986-87	33.2	130.0	3.92
1991-92	34.4	144.0	4.19
1996-97	34.4	142.0	4.13
2001-02	36.8	150.0	4.07
2004-05	86.4	589.4	6.82

2005-06	115.6	769.0	6.65
2006-07	128.7	894.0	6.94
2007-08	125.1	889.0	7.11
Garlic			
1971-72	13.4	49.0	3.66
1976-77	11.7	38.0	3.25
1981-82	12.9	42.0	3.26
1986-87	12.5	36.0	2.88
1991-92	12.5	40.0	3.20
1996-97	13.0	39.0	3.00
2001-02	14.2	41.0	2.90
2004-05	25.6	90.2	3.52
2005-06	26.6	102.0	3.85
2006-07	38.8	177.0	4.55
2007-08	33.6	145.0	4.32
Ginger			
1971-72	4.9	34.0	6.94
1976-77	5.3	35.0	6.60
1981-82	6.5	41.0	6.31
1986-87	6.1	40.0	6.56
1991-92	6.9	42.0	6.09
1996-97	6.9	39.0	5.65
2001-02	7.7	43.0	5.59
2004-05	7.7	49.4	6.42
2005-06	8.0	57.0	7.10
2006-07	8.5	63.0	7.41
2007-08	9.3	76.0	8.17

Source : BBS, 2009c

Table 15. Projected demand for 6 major spices in Bangladesh on the basis of projected population by the year 2030-31.

Indices	2006-07	2010-11	2020-21	2030-31
Population (million)	142.60	151.41	171.71	191.60
Production of spices (000 mt)	1406	1406*	1406*	1406*
Demand for spices (000 mt)	2600	2760	3131	3493
Production and demand gap for spices (000 mt)	1184	1354	1725	2087

*Considering the level of production same as of 2006-07. Source : BBS, 2008

The present export of spices from Bangladesh is negligible. Only a small quantity of green chillies and some powdered hot chillies, turmeric and coriander are exported to some European and Middle-East markets. Investments in the large scale production of spice powder and paste in factories for local and foreign markets are increasing.

5e. Flowers and ornamentals

Floriculture is a growing industry in Bangladesh. Commercial production and marketing of cut flowers, saplings of ornamental plants and potted ornamentals has emerged as an important potential area of agri-business in this country in the recent years (Rashid, 2003; Dadlani, 2004) Nursery business is a good source of income for many male and female persons throughout the country, and most of the nurseries have some involvement with production and marketing of flowers and ornamentals.

Cut flower business is growing rapidly in this country. The major production areas of cut flowers are Dhaka, Chittagong, Cox's Bazar, Jessore, Chuadanga, Jhenidah, Bogra, Rangpur, Kushtia and Mymensingh. The most important cut flowers of Bangladesh are, rose, tuberose, gladiolas, marigold and kathbeli, and the present total area under cultivation of different cut flowers and foliages is about 3350 hectares (Miah *et al.*, 2006). On the other hand, the major production areas of ornamental plants are, Khulna, Pirojpur, Natore, Dhaka, Chittagong and Mymensingh.

The major ornamental plants maintained in different nurseries for sale are, Crotons, Ixora, Thuza, Palms, Araucaria, Musaenda, Dahlia, Cactus, Ferns, Aralias, Dracaena, China Box, Century Plants, Bromeliads, Needle Pine, Chlorodendram, Hydrangea and Kalonche. The ornamental plants maintained in the nurseries are either produced by the nurserymen or collected from local and foreign sources. The approximate area under nurseries producing ornamental plants is about 1100 hectares, and the total area of land under the floriculture industry at present is about 4450 hectare (Miah *et al.*, 2006).

The traders play an important role in the marketing of flowers, and the number of traders in flower business is about 1200 to 1500 in the country. The major markets of floriculture products are in Dhaka, Chittagong, Gothkhali (Jessore), Feni, Rangpur, Phultala (Khulna), Sorupkathi, Natore, Bogra and Mymensingh. The annual turn out in the whole sale markets is more than Tk.100 crore, and in the retail market it is about Tk.200 crore. It is estimated that about 80-90 thousand people of the country are directly or indirectly involved in the floriculture industry for livelihood.

The scope for export of cut flowers and ornamentals from Bangladesh has not yet been properly explored. In the year 2004-05, an amount of US\$73,39,000 was earned through export of flowers and ornamentals (EPB, 2005). On the other hand, the import of flowers and ornamental plants would be worth of around Tk.2-3 million per year. Generally, chrysanthemum, tuberose and gladiolus are imported from India, and orchids, gerbera, anthurium and roses

are imported from Thailand. Smuggling in of cut flowers and ornamental plants is a common practice in the south-western border belts of Bangladesh.

Employment generation for both male and female persons, increase in growth of market size both at home and abroad and high economic return are the main potentialities of the floriculture industry of Bangladesh. An estimate of high economic return in production of cut flowers has been shown in Table 16.

Table 16. Cost and economic return in the production of some cut flowers.

Flower crops	Cost of production (000 Tk / ha)	Net income (000 Tk / ha)	BCR
Rose	391	102	1.3
Tube rose	176	219	2.2
Gladiolus	403	313	1.3
Marigold	105	93	1.9

Source : Miah et al., 2006

The marketing of cut flowers in Bangladesh is not well-organized. Standard techniques are generally not used in the post-harvest handling processes. Unhygienic handling, rough packaging and rough transport are most common. The sources of most of the cut flowers in the Shahbag whole sale market (Dhaka) are as follows (Rabbani, 2005):

Rose - Savar, Balur ghat, Godkhali, Chokoria
 Gladiolus - Savar, Godkhali, Balurghat
 Tube rose - Godkhali, Jibon Nagar, Chuadanga
 Marigold - Kaligonj, Jibon Nagar, Chuadanga
 Orchids - Fulbaria (Dipta Orchids), Savar
 China Belly - Narayanganj, Sonargaon
 Golden rod – Godkhali.

The cut flowers from Shahbag whole sale market generally go to the retail markets of Dhaka city, Sylhet, Chittagong, Comilla, Norsingdi, Feni and Rangpur. The whole sale price per 100 pieces is Tk.100-200 for rose, Tk.100-140 for tube rose (double), Tk.300-400 for gladiolus and Tk.1000-1500 for orchids; and at the retail markets the price for 100 piece of rose is Tk.300-500, tube rose is Tk.200-300, gladiolus is Tk.400-500 and orchids is Tk.1500-2000 (Rabbani, 2005).

The major problems / constraints in the floriculture industry of Bangladesh appear to be as follows:

(a) access to modern varieties and quality planting material; **(b)** narrow diversity in product range and poor quality of flowers and ornamental plants; **(c)** high cost of production; **(d)** inadequate knowledge and use of traditional

practices in the production and post-harvest handling techniques; **e)** poor marketing system with little or no regard to modern techniques in sorting, grading, packaging, transport and value addition; **f)** poor knowledge on plant nutrition, diseases and insect pests, and improper use of agro-chemicals and **g)** absence of systematic research, and lack of scientific intervention in the production, post-harvest management and marketing of flowers and ornamental plants in the country.

6. Prioritization of horticultural crops for research

The horticulture sub-sector, comprising fruits, vegetables, roots & tubers, spices and flowers & ornamentals, covers hundreds of crop species. Many of those crops are of major importance, while most are of minor importance. There is a wide variation among the horticultural crops in respect of morphological features, growth habit, area under cultivation, total production and use. Horticultural research in Bangladesh should therefore be emphasized particularly on crops having economic and / or nutritional importance. Scope for commercial production, processing and export are the other considerations. Crops having high values, suitable for production under the different agro-ecological conditions of Bangladesh and demonstrating potentiality for improvement should also be included in the priority list. Nevertheless, research on highly demanded exotic horticultural crops suitable for introduction should also get priority. It is therefore important to prioritize horticultural crops for carrying out research covering the selected 5 thematic areas. A suggested list of priority crops under fruits, vegetables, roots & tubers, spices and flowers & ornamentals is furnished below :

Fruits	Vegetables	Roots& Tubers	Spices	Flowers& Ornamentals
Banana	Brinjal	Potato	Onion	Orchid
Pineapple	Tomato	Sweet potato	Garlic	Rose
Papaya	Pumpkin	Mukhi kachu	Chilli	Gladiolus
Mango	Cucumber	Pani kachu	Ginger	Tube rose
Jackfruit	Radish	Ol kachu	Turmeric	Marigold
Guava	Carrot	Man kachu	Coriander	Dahlia
Litchi	Okra	Yams		Chrysanthemum
Jujube	Cabbage	Cassava		Cactus
Lime & Lemon	Cauliflower			Palms
Melons	Bottle gourd			Araucaria
Coconut	Beans			Musaenda
Exotic fruits	Pointed gourd			Gerbera
	Bitter gourd			
	Teasel gourd			
	Snake gourd			
	Ribbed gourd			

7. Research priorities under the selected thematic areas

As stated under the 'Activities performed by the Horticultural Crops Group' part, 5 most urgent, important and result-oriented *thematic areas* (Research Agenda) were selected through a number of consultation meetings and personal interviews. The selected thematic areas are as follows:

1. Variety development and conservation of plant genetic resources
2. Production technology
3. Seed and quality planting material
4. Post-harvest management
5. Agri-business in horticulture

The research priorities under each of the 5 thematic areas are presented below. The listed research priorities were formulated considering the opinion of the participants of group consultation meetings, personal interviews, recommendations of the Regional Workshops and information available in some relevant documents (Siddique and Rashid, 1999; BARC, 2000; Ghosh and Khan, 2002; Banik, 2005; Miah *et al.*, 2006; HRC, 2007; Hossain *et al.*, 2008; Ahmed, 2009; HRC, 2009a; HRC, 2009b; Huda, 2009; Rabbani *et al.*, 2009; SRC, 2009; TCRC, 2009; Bhuyan and Hossain, 2009).

7a.a. FRUITS : VARIETY DEVELOPMENT AND CONSERVATION OF PLANT GENETIC RESOURCES

Research Area		<i>Horticultural Crops</i>			
Sub-Area		<i>Fruits</i>			
Research Agenda / Thematic Area		<i>Variety Development and Conservation of Plant Genetic Resources</i>			
Problem/ Constraints	Research Title/ Key Words	%of benefic.	Prob. of success	Prior. rank	Res. Tenure
Erosion of local genetic resources of fruits	Collection, evaluation and conservation (field and <i>in-vitro</i>) of local germplasm / landraces		High	1	Long
Not enough good quality and high yielding varieties of major / important fruits	Development of improved varieties (high yielding as well as good quality) of major / important fruits through selection from local material, introduction and hybridization		High	1	Long
Varietal characters of recommended / released varieties not well-documented	Maintenance of recommended / released varieties ; Morphological and molecular characterization of recommended / released varieties		High	1	Long
High incidence of disease and insect pests	Development of disease tolerant / resistant varieties through conventional and modern techniques of breeding		Medium	1	Long

Varieties for specific purposes are not available	Development of varieties for specific purposes (e.g., processing, export)		Medium	2	Long
Some recommended / released varieties are not popular	Socio-economic study / survey study on acceptability of recommended / released varieties		High	1	Short
Degeneration of recommended / released varieties	Purification and maintenance of degenerated varieties		High	1	Long
Poor performance in high density planting	Development of varieties suitable for high density planting		High	2	Long
Poor performance in hilly regions	Development of varieties suitable for hilly regions		High	2	Long
Poor performance in saline areas	Development of varieties for saline areas		Medium	2	Long
Poor performance in high humid areas	Development of varieties for high humid areas		Medium	2	Long
Alternate bearing	Development of regular bearing varieties		Medium	2	Long
Seasonality in harvesting of fruits	Development of early, medium and late maturing varieties as well as varieties suitable for off-season production		High	1	Long

7a.b. FRUITS : *PRODUCTION TECHNOLOGY*

Research Area		<i>Horticultural Crops</i>			
Sub-Area		<i>Fruits</i>			
Research Agenda / Thematic Area		<i>Production Technology</i>			
Problems / Constraints	Research Title / Key Words	% of benefic.	Prob. of success	Prio. rank	Res. Tenure
Recommendations on manure and fertilizer application do not perform well	Standardization of dose and method of application of manures and fertilizers for different fruit crops		High	1	Long
Recommendations for high density planting are not proper	Development of technology for high density planting of quick growing and tree / shrubby fruit plants		High	1	Long
Appropriate recommendations for practices like training, pruning and fruit thinning not available	Development of training, pruning and fruit thinning practices specific to fruit crop and variety		Medium	2	Long
Recommendations for intercropping in fruit gardens are not well-tested	Study on intercropping in quick growing fruits and in established fruit orchards		High	1	Long
Loss due to attack of some major insect pests is high in some fruits	Management of major insect pests of commercially important fruits		Medium	1	Long

Loss due to some major diseases is high in some fruits	Management of major diseases of commercially important fruits		Medium	1	Long
Poor yield and quality of fruits due to water stress	Study on water requirement, irrigation technique and use of mulch in fruit production		High	1	Medium
Locally produced fruits are not uniformly available throughout the year	Development of technology for off-season, year round and lean season production of fruits		Medium	1	Long
Impact of developed production technologies not known	Socio-economic study on the impact of improved technologies on fruit production		High	1	Short
Quality of fruits for processing and export is not well-acceptable	Development of technology for processing and export oriented production of fruits		High	2	Long
Technology for use of growth regulating chemicals in flower induction, fruit setting and prevention of fruit drop is inadequate	Study on dose and method of application of growth regulating chemicals for flower induction, increased fruit set and reduced fruit drop in different fruit crops		High	1	Medium
Poor economic return in the production of some fruits	Study of different levels of input use and manipulation of production technology on yield and economic return from different fruits		High	2	Medium
Inadequate high tech production technologies	Development of cost-effective high tech production technologies particularly for quick growing fruits		Medium	2	Medium
Inadequate production technology for growing fruits in hilly regions	Development of appropriate production technologies for growing fruits in hilly regions		High	2	Long
Appropriate technologies for growing fruits in saline areas are lacking	Development of appropriate production technologies for growing fruits in saline areas		Low	1	Long
Technologies for homestead production of fruits are inadequate	Development of appropriate technologies for production of fruits in homestead		Medium	2	Long

7a.c. FRUITS : SEED AND QUALITY PLANTING MATERIAL

Research Area		<i>Horticultural Crops</i>			
Sub-Area		<i>Fruits</i>			
Research Agenda / Thematic Area		<i>Seed and Quality Planting Material</i>			
Problems / Constraints	Research Title / Key Words	% of benefic.	Prob. of success	Prio. rank	Res. tenure
Techniques of veg. propagation of tree and shrubby fruit plants not always advantageous	Standardization of vegetative propagation techniques for quick multiplication of different shrubby and tree fruit plants		High	2	Medium
Grafted and budded fruit saplings do not perform well in hilly and saline areas	Standardization of rootstocks suitable for hilly and saline areas for grafting and budding of fruit plants.		Medium	1	Medium

Good planting materials of banana, pineapple and papaya are not always available	Development of technology for propagation of banana, pineapple and papaya using tissue culture techniques		Medium	2	Long
Quality seeds of recommended / released varieties of sexually propagated fruits not available	Development of technology for quality seed production of recommended / released varieties of sexually propagated fruit crops, e.g., papaya, melons and coconut		High	1	Medium
Quality rootstocks are often not available for grafting and budding	Development of technology for production and maintenance of quality rootstocks for grafting and budding of different fruit plants		High	1	Medium
Saplings of different fruits available in nurseries are often not very healthy	Standardization of management practices for saplings of different fruit plants maintained in nurseries		High	2	Medium
Only seed propagated saplings of jackfruit available	Study on production of jackfruit saplings through vegetative propagation		Medium	2	Medium
All jackfruit trees in old and new orchards are seed propagated	Study on improvement of jackfruit trees through top-working		Medium	2	Short
Air-layering is relatively a difficult method for propagation of litchi, guava and citrus fruits	Study on propagation of litchi, guava and citrus fruits through grafting and budding		Medium	2	Medium
Pineapple suckers of desirable type and uniform size are not abundantly available for commercial planting	Study on growth and pre-planting management of pineapple suckers		High	1	Medium
Growth and development of banana plants not uniform due to variation in planting material	Study on selection and pre-planting management of banana planting material (suckers and corms)		High	2	Medium

7a.d. FRUITS : POST-HARVEST MANAGEMENT

Research Area		Horticultural Crops			
Sub-Area		Fruits			
Research Agenda / Thematic Area		Post-harvest Management			
Problems / Constraints	Research Title / Key Words	% of benefic.	Prob. of success	Prio. rank	Res. tenure
Maturity indices for different fruits not well-defined	Standardization of maturity indices for different fruits specific to use		High	1	Medium
Post-harvest handling techniques for different fruits not well-defined	Standardization of post-harvest handling practices for different fruits		High	1	Medium
Techniques of value addition for different fruits are not known	Development of value addition techniques for different fruits as per market demand		Medium	2	Medium

Estimates of post-harvest losses of different fruits are not precise	Study on post-harvest losses of fruits (quantitative) at different stages of marketing		Medium	1	Medium
Post-harvest losses of different fruits are high	Development of pre-harvest, harvest and post-harvest techniques for minimizing post-harvest loss of different fruits		High	1	Medium
Post-harvest deterioration in fruit quality is not known	Estimation and control of post-harvest deterioration in edible and nutritional quality of fruits		High	2	Medium
Extensive use of harmful chemicals for ripening of fruits	Development of environment friendly and human health hazard free technology for ripening and extending shelf life of fruits		High	1	Medium
Extensive and indiscriminate use of pesticides in fruits leads to health hazard	Estimation of pesticide residues in harvested fruits in relation to dose and method of application of fungicides and insecticides		Medium	2	Medium
Post-harvest loss in quality of fruits due to microbial contamination	Control of post-harvest loss in quality of fruits through reduction of microbial contamination		Medium	2	Medium
There is no standard of product quality for fruits	Development of standard of product quality for fresh fruits		High	2	Short
Poor shelf life of local fruits	Extension of shelf life of fruits through environment friendly and human health hazard free techniques		Medium	1	Medium
Level of pesticide residues and toxic chemicals in imported fruits is not known	Estimation of pesticide residues and health hazardous chemicals present in imported fruits		High	1	Medium
Marketing system of fruits is not defined and poor	Market research leading to improvement in the marketing of fruits		High	1	Medium

7a.e. FRUITS : AGRI-BUSINESS IN HORTICULTURE

Research Area		Horticultural Crops			
Sub-Area		Fruits			
Research Agenda / Thematic Area		Agri-business in Horticulture			
Problem / Constraints	Research Title / Key Words	% of benefic.	Prob. of success	Prio. rank	Res. tenure
Production of quality packaging materials and containers for marketing of local fruits not adequate	Development of standard packaging materials and containers for marketing of local fruits – leading to development of packaging material industry as an Agri-business		High	2	Medium
The quantity of fruits exported per year is very small	Development of technology for growing of export quality fruits – leading to development of contract growing of fruits for export as an Agri-business		High	1	Medium

Spraying of pesticides and growth regulating chemicals in fruit trees is difficult for the growers	Development of low cost equipment and technique for effective spraying of pesticides and growth regulators in fruit trees – leading to spraying in fruit trees on contract basis as an Agri-business		High	1	Medium
By-products of harvested fruits are not utilized	Development of technology for utilization of the by-products of fruits - leading to development of fruit by-product utilization industry as an Agri-business		Medium	2	Medium
Locally produced minor fruits are not sold in an attractive price	Development of product quality and value addition techniques for good marketing of locally produced minor fruits - leading to development of marketing of minor fruits as an Agri-business		Medium	2	Short
The size and quality of locally produced fruits often do not suit for processing	Development of technology for contract growing of processing quality fruits – leading to development of contract growing of processing quality fruits as an Agri-business		Medium	2	Medium
Small scale production of quality processed fruit items is inadequate	Development of technology for small scale production of processed fruit items – leading to development of small scale fruit processing industry as an Agri-business		Medium	2	Short
Protected farming for high value fruit crop production is inadequate	Development of protected farming models for high value fruit crop production – leading to development of protected high value fruit farming industry as an Agri-business		Low	3	Medium
Supply of organic farm produced fruits is limited	Development of technology for production of fruits in organic farming system – leading to development of organic fruit production as an Agri-business		Low	3	Medium
The period of availability of local fruits in the market is very short	Development of technology for short term storage of fruits in small scale – leading to development of small scale fruit storage industry as an Agri-business		Medium	1	Medium
Care & management of mother plants and saplings of fruits in nurseries are inadequate	Improvement of care and management practices in nurseries for fruit plants – leading to development of ideal nurseries for fruit plants as an Agri-business		Medium	2	Medium

Supply of high quality seeds of sexually propagated fruits is limited	Development of technology for production and processing of high quality seeds of fruit crops – leading to production and marketing of high quality seeds of fruits as an Agri-business		Medium	1	Medium
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7b.a. VEGETABLES : VARIETY DEVELOPMENT AND CONSERVATION OF PLANT GENETIC RESOURCES

Research Area		<i>Horticultural Crops</i>			
Sub-Area		<i>Vegetables</i>			
Research Agenda / Thematic Area		<i>Variety Development and Conservation of Plant Genetic Resources</i>			
Problem/ Constraints	Research Title/ Key Words	%of benefic.	Prob. of success	Prior. rank	Res. Tenure
Erosion of local genetic resources of vegetables	Collection, evaluation and conservation (seed and <i>in-vitro</i>) of local germplasm / landraces of vegetables		High	1	Long
Not enough good quality and high yielding op varieties of major / important vegetables	Development of improved op varieties (high yielding as well as good quality) of major / important vegetable crops through selection from local material, introduction and hybridization		High	1	Long
Only a few hybrid vegetable varieties developed in the country	Development of hybrid varieties of important vegetable crops (namely, tomato, brinjal, chilli, cauliflower) and maintenance of parent lines		High	1	Long
Varietal characters of recommended / released varieties not well-documented	Morphological and molecular characterization of recommended / released varieties of vegetables		High	1	Long
High incidence of disease and insect pests	Development of disease and insct tolerant / resistant varieties of vegetables through conventional and modern techniques of breeding		Medium	1	Long
Varieties for specific purposes are not enough	Development of varieties for specific purposes (e.g., processing and export)		Medium	2	Long
Some recommended / released varieties are not popular	Socio-economic study / survey study on acceptability of recommended / released varieties of vegetables		High	1	Short
Degeneration of recommended / released varieties of vegetables	Purification of degenerated varieties of vegetables		High	1	Long

Poor performance of some vegetables in high density planting	Development of varieties of vegetables suitable for high density planting		Medium	2	Long
Poor performance of vegetable crops in saline areas	Development of varieties of vegetables suitable for saline areas		Medium	1	Long
Seasonality in production	Development of early, medium and late varieties of vegetables, as well as varieties suitable for off-season production		Medium	2	Long

7b.b. VEGETABLES : *PRODUCTION TECHNOLOGY*

Research Area		<i>Horticultural Crops</i>			
Sub-Area		<i>Vegetables</i>			
Research Agenda / Thematic Area		<i>Production Technology</i>			
Problems / Constraints	Research Title / Key Words	% of benefic.	Prob. of success	Prio. rank	Res. Tenure
Recommendations on manure and fertilizer application do not perform well	Standardization of dose and method of application of manures and fertilizers for different vegetables		High	1	Medium
Appropriate recommendations for practices like pruning and fruit thinning not available	Development of pruning and fruit thinning practices specific to vegetable crop and variety		High	2	Medium
Recommendations for intercropping and mixed cropping are not well-tested	Study on intercropping and mixed cropping in vegetable crops		High	2	Medium
Loss due to attack of some major insect pests is high in some vegetables	Management of major insect pests of important vegetable crops		Medium	1	Medium
Loss due to some major diseases is high in some vegetables	Management of major diseases of important vegetable crops		Medium	1	Medium
Poor yield and quality of vegetables due to water stress	Study on water requirement, irrigation technique and use of mulch in vegetable production		Medium	1	Medium
Some vegetables are not uniformly available throughout the year	Development of technology for off-season, year round and lean season production of vegetables		Medium	2	Medium
Impact of developed production technologies not known	Socio-economic study on the impact of improved technologies on vegetable production		High	1	Short
Quality of vegetables for processing and export is not well-acceptable	Development of technology for processing and export oriented production of vegetables		Medium	2	Medium

Technology for use of growth regulating chemicals in flower induction, fruit setting and prevention of fruit drop is inadequate	Study on dose and method of application of growth regulating chemicals for flower induction, increased fruit set and reduced fruit drop in different vegetable crops		Medium	2	Short
Poor economic return in the production of some vegetables	Study of different levels of input use and manipulation of production technology on yield and economic return from different vegetables		High	2	Medium
Inadequate high tech production technologies	Development of cost-effective high tech production technologies particularly for high value vegetable crops		Medium	2	Short
Inadequate production technology for growing vegetables in hilly regions	Development of appropriate production technologies for growing vegetables in hilly regions		Medium	2	Medium
Appropriate technologies for growing vegetables in saline areas are lacking	Development of appropriate production technologies for growing vegetables in saline areas		Medium	1	Medium
Technologies for homestead production of vegetables are inadequate	Development of appropriate technologies for production of vegetables in homestead		Medium	2	Medium
Technologies for production of vegetables in Bill, Haor and Charland, areas are inadequate	Development of appropriate technologies for production of vegetables in Bill, Haor and Charlands areas		Medium	2	Medium

7b.c. VEGETABLES : SEED AND QUALITY PLANTING MATERIAL

Research Area		Horticultural Crops			
Sub-Area		Vegetables			
Research Agenda / Thematic Area		Seed and Quality Planting Material			
Problems / Constraints	Research Title / Key Words	% of benefic.	Prob. of success	Prio. rank	Res. tenure
Quality seeds of recommended / released op varieties of vegetables not available	Development of technology for quality seed production of registered / recommended / released op varieties of vegetables		High	1	Medium
Quality seeds of recommended / released hybrid varieties of vegetables not available	Development of technology for quality seed production of registered / recommended / released hybrid varieties of vegetable; and maintenance of parent lines		High	1	Medium
Quality and yield of breeders', foundation, certified and TL seeds of vegetable crops not adequate	Improvement of technology for production of breeder, foundation, certified and TL seeds of different vegetable crops		High	1	Medium

Vegetable seeds retained at farmers' house generally do not perform well	Development of technology for better storage of vegetable seeds at farmers' level		High	1	Medium
Vegetable growers are not able to judge the quality of their own as well as procured seeds	Development of easy techniques for judging the quality of vegetable seeds at farmers' level		High	1	Short
Quality planting materials of asexually propagated vegetable crops not available	Development of technology for production and maintenance of high quality planting materials of asexually propagated vegetable crops, namely, pointed gourd and Kakrol		High	1	Medium

7b.d. VEGETABLES : *POST-HARVEST MANAGEMENT*

Research Area		<i>Horticultural Crops</i>			
Sub-Area		<i>Vegetables</i>			
Research Agenda / Thematic Area		<i>Post-harvest Management</i>			
Problems / Constraints	Research Title / Key Words	% of benefic.	Prob. of success	Prio. rank	Res. tenure
Maturity indices for different vegetables not well-defined	Standardization of maturity indices for different vegetables, specific to use		High	1	Medium
Post-harvest handling techniques for vegetables not well-defined	Standardization of post-harvest handling practices for different vegetables		High	1	Short
Techniques of value addition for veg. crops not known	Development of value addition techniques for different vegetables as per market demand		Medium	2	Short
Estimates of post-harvest losses of vegetables not precise	Study on post-harvest losses of vegetables (quantitative) at different stages of marketing		Medium	1	Medium
Post-harvest losses of different vegetables are high	Development of pre-harvest, harvest and post-harvest techniques for minimizing post-harvest loss of different vegetables		High	1	Medium
Post-harvest deterioration in vegetable quality not known	Estimation and control of post-harvest deterioration in edible and nutritional quality of vegetables		High	2	Medium
Extensive and indiscriminate use of pesticides in vegetables leads to health hazard	Estimation of pesticide residues in harvested vegetables in relation to dose and method of fungicides and insecticide application		Medium	2	Medium
Post-harvest loss in quality of vegetable due to microbial contamination	Control of post-harvest loss in quality of vegetables through reduction of microbial contamination		Medium	2	Medium
There is no standard of product quality for fresh vegetables	Development of standard of product quality for fresh vegetables		High	2	Short
Poor shelf life of vegetables	Extension of shelf life of vegetables through environment friendly and health hazard free techniques		Medium	1	Medium

Level of pesticide and toxic chemical residues in imported vegetables not known	Estimation of pesticide residues and health hazardous chemicals present in imported /smuggled in vegetables (namely, tomato)		High	2	Short
Vegetables are perishable, and cannot be stored under ordinary conditions	Development of technology for short term storage of fresh vegetables		Medium	2	Medium
Marketing system of vegetables is not defined and poor	Market research leading to improvement in the marketing of vegetables		High	1	Medium

7b.e. VEGETABLES : AGRI-BUSINESS IN HORTICULTURE

Research Area		Horticultural Crops			
Sub-Area		Vegetables			
Research Agenda / Thematic Area		Agri-business in Horticulture			
Problem / Constraints	Research Title / Key Words	% of benefic.	Prob. of success	Prio. rank	Res. tenure
Production of quality packaging materials and containers for marketing of vegetables not adequate	Development of standard packaging materials and containers for marketing of vegetables, like, tomato – leading to development of packaging material production industry as an Agri-business		High	2	Medium
The quantity of vegetables exported per year from Bangladesh is very small	Development of technology for contract growing of export quality vegetables – leading to development of contract growing of vegetables for export as an Agri-business		High	1	Medium
The size and quality of locally produced vegetables often do not suit for processing	Development of technology for contract growing of processing quality vegetables – leading to development of contract growing of processing quality vegetables as an Agri-business		Medium	2	Medium
Small scale production of quality processed vegetable items is inadequate	Development of technology for small scale production of processed vegetable items – leading to development of small scale vegetable processing industry as an Agri-business		Medium	2	Short
Protected farming for high value vegetable crop production is inadequate	Development of protected farming models for high value vegetable crop production – leading to development of protected high value vegetable farming industry as an Agri-business		Low	3	Medium
Supply of organic farm produced vegetables is limited	Development of technology for production of vegetables in organic farming system – leading to development of organic vegetable production as an Agri-business		Low	3	Medium

The period of availability of some vegetables in the market is very short	Development of technology for short term storage of vegetables in small scale – leading to development of small scale vegetable storage industry as an Agri-business		Medium	1	Medium
Supply of high quality vegetable seeds is limited	Development of technology for high quality vegetable seed production on contract basis – leading to production of high quality vegetable seeds as an Agri-business		High	1	Medium

**7c.a. ROOTS AND TUBERS : VARIETY DEVELOPMENT AND
CONSERVATION OF PLANT GENETIC RESOURCES**

Research Area		<i>Horticultural Crops</i>			
Sub-Area		<i>Roots and Tubers</i>			
Research Agenda / Thematic Area		<i>Variety Development and Conservation of Plant Genetic Resources</i>			
Problem/ Constraints	Research Title/ Key Words	%of benefic.	Prob. of success	Prior. rank	Res. Tenure
Erosion of local genetic resources of roots and tubers	Collection, evaluation and conservation of local germplasm of root and tuber crops		High	1	Long
Not many good quality and high yielding varieties of major / important root and tuber crops	Development of improved varieties (high yielding as well as good quality) of major / important root and tuber crops (potato, sweet potato, Mukhi kachu and Pani Kachu) through selection from local and exotic materials, introduction and hybridization ; utilization of heterosis where possible		High	1	Long
Varietal characters of recommended / released varieties not well-documented	Morphological and molecular characterization of recommended / released varieties of root and tuber crops		High	1	Medium
High incidence of disease and insect pests	Development of disease tolerant / resistant varieties through conventional and modern techniques of breeding		Medium	2	Long
Varieties for specific purposes are not enough	Development of varieties of root and tuber crops for specific and dual purposes (e.g., processing and export)		High	1	Medium
Some of the recommended / released varieties are not popular	Socio-economic study / survey study on acceptability of recommended / released varieties of root and tuber crops		High	1	Short
Degeneration of recommended / released varieties	Development of disease-free planting material of the degenerated recommended / released varieties through tissue culture		Medium	2	Medium
Poor performance in saline areas	Development of varieties of root and tuber crops for saline areas ; transgenic variety development		Medium	1	Medium
Harvesting period is short	Development of early, medium and late varieties, as well as varieties suitable for off-season production		Medium	2	Medium
Late blight is a serious problem for potato	Development of late blight resistant varieties of potato ; transgenic variety development		Medium	1	Medium
Most of the varieties of roots and tubers are long duration crops	Development of short duration varieties through selection, introduction and other possible ways of crop improvement		Medium	1	Medium
Only a few released varieties of TPS	Development of high yielding and disease resistant TPS varieties having good quality tubers		Medium	2	Medium

7c.b. ROOTS AND TUBERS : *PRODUCTION TECHNOLOGY*

Research Area		<i>Horticultural Crops</i>			
Sub-Area		<i>Roots and Tubers</i>			
Research Area / Thematic Area		<i>Production Technology</i>			
Problems / Constraints	Research Title / Key Words	% of benefic.	Prob. of success	Prio. rank	Res. Tenure
Recommendations on manures and fertilizers not effective	Standardization of application of manures and fertilizers for different root and tuber crops		High	1	Medium
Recommendations for intercropping are not well-tested	Study on intercropping in root and tuber crops		High	2	Medium
Loss due to some major insect pests attack is high	Management of major insect pests of important root and tuber crops		Medium	2	Medium
Loss due to some major diseases is high	Management of major diseases of important root and tuber crops		Medium	1	Medium
Poor yield and quality due to water stress	Study on water requirement, irrigation and use of mulch in root and tuber crop production		High	1	Medium
Some root and tubers are not uniformly available throughout the year	Development of technology for off-season, year round and lean season production of some root and tuber crops		Medium	2	Medium
Impact of developed production technologies not known	Socio-economic study on the impact of improved technologies on root and tuber crop production		High	1	Short
Quality of some root and tubers for processing and export is not well-acceptable	Development of technology for processing and export oriented production of some root and tuber crops (namely, potato)		High	1	Medium
Poor economic return in the production of some root and tuber crops	Study of different levels of input use and manipulation of production technology on yield and economic return of different root and tuber crops		High	2	Medium
Inadequate production technology for growing root and tuber crops in hilly regions	Development of appropriate production technologies for growing root and tuber crops in hilly regions		Medium	2	Medium
Appropriate technologies for growing root and tuber crops in saline areas are lacking	Development of appropriate production technologies for growing root and tuber crops in saline areas		Medium	1	Medium
Technologies for production of root and tuber crops in Bill, Haor and Charland areas are inadequate	Development of appropriate technologies for production of root and tuber crops in Bill, Haor and Charland areas		Medium	2	Medium

7c.c. ROOTS AND TUBERS : SEED AND QUALITY PLANTING MATERIAL

Research Area		<i>Horticultural Crops</i>				
Sub-Area		<i>Roots and Tubers</i>				
Research Agenda / Thematic Area		<i>Seed and Quality Planting Material</i>				
Problems / Constraints	Research Title / Key Words	% of benefic.	Prob. of success	Prio. rank	Res. tenure	
Quality planting material of recommended / released varieties not available	Development of technology for production of quality planting material of recommended / released varieties of root and tuber crops		High	1	Medium	
Quality and yield of breeders' , foundation, certified and TL seed potatoes not adequate	Improvement of technology for production of breeders' , foundation, certified and TL seed potatoes		High	1	Medium	
About 94 % of total seed potatoes used in Bangladesh is poor quality Farmers' seed	Improvement in quality of Farmers' seed potatoes		High	1	Medium	
Production and supply of Breeder's / Basic seed potatoes is limited	Improvement in technology for increased production of Breeder's / Basic seed potatoes		High	1	Medium	
Seed potatoes either produced or imported by private sector often do not perform well	Development of easy and low cost technique for evaluation of the quality of locally produced and imported seed potatoes		High	1	Short	
Cost of production per kg seed potato is high	Manipulation of production technology leading to reduced cost per kg seed potato		High	1	Medium	
Quality of potato micro and mini tubers produced in some tissue culture labs not satisfactory	Development of technique for evaluation of the standard and performance of tissue culture labs producing basic seed potatoes		Medium	1	Medium	
Quality planting material of sweet potato and aroids not available	Standardization of technology for the production of quality planting materials for sweet potato and aroids		Medium	1	Medium	

7c.d. ROOTS AND TUBERS : POST-HARVEST MANAGEMENT

Research Area		<i>Horticultural Crops</i>				
Sub-Area		<i>Roots and Tubers</i>				
Research Agenda / Thematic Area		<i>Post-harvest Management</i>				
Problems / Constraints	Research Title / Key Words	% of benefic.	Prob. of success	Prio. rank	Res. tenure	
Maturity indices for different root and tuber crops not well-defined	Standardization of maturity indices for different root and tuber crops		High	1	Medium	

Post-harvest handling techniques for different root and tuber crops not well-defined	Standardization of post-harvest handling practices for different root and tuber crops		High	1	Short
Techniques of value addition for different root and tuber crops not known	Development of value addition techniques for different root and tuber crops as per market demand		Medium	2	Short
Estimates of post-harvest losses of different root and tuber crops not precise	Study on post-harvest losses of root and tuber crops (quantitative) at different stages of marketing		Medium	1	Medium
Post-harvest losses of different root and tuber crops are high	Development of pre-harvest, harvest and post-harvest techniques for minimizing post-harvest loss of root and tuber crops		High	1	Medium
Post-harvest deterioration in quality of root and tuber crops not known	Estimation and control of post-harvest deterioration in edible and nutritional quality of vegetables		High	2	Medium
Extensive and indiscriminate use of pesticides in root and tuber crops leads to human health hazard	Estimation of pesticide residues in harvested root and tuber crops in relation to dose and method of fungicide and insecticide application		Medium	2	Medium
Post-harvest loss in quality of root and tuber crops due to microbial contamination	Control of post-harvest loss in quality of root and tuber crops through reduction of microbial contamination		Medium	2	Medium
There is no standard of product quality for root and tuber crops	Development of standard of product quality for fresh roots and tubers		Medium	2	Short
Poor shelf life of roots and tubers	Extension of shelf life of root and tuber crops through use of environment friendly and human health hazard-free techniques		Medium	1	Medium
Roots and tubers are perishable, and cannot be stored under ordinary conditions	Development of technology for short term storage of root and tuber crops ; standardization of techniques for long term storage of potatoes in cold stores		Medium	1	Medium
Marketing system of roots and tubers is not defined and poor	Market research leading to improvement in the marketing of roots and tubers		High	1	Medium

7c.e. ROOTS AND TUBERS : AGRI-BUSINESS IN HORTICULTURE

Research Area		<i>Horticultural Crops</i>			
Sub-Area		<i>Roots and Tubers</i>			
Research Agenda / Thematic Area		<i>Agri-business in Horticulture</i>			
Problem / Constraints	Research Title / Key Words	% of benefic.	Prob. of success	Prio. rank	Res. tenure
Quality packaging materials for marketing of root and tubers not available	Development of standard packaging materials for marketing of root and tuber crops – <i>leading to development of packaging material industry as an Agri-business</i>		Medium	2	Medium
Quantity of roots and tubers exported from Bangladesh per year is very small	Development of technology for contract growing of export quality roots and tubers – <i>leading to development of contract growing of roots and tubers for export as an Agri-business</i>		High	1	Medium
Size and quality of locally produced roots and tubers often not suitable for processing	Development of technology for contract growing of processing quality roots and tubers, e.g., potato – <i>leading to contract growing of processing quality roots and tubers as an Agri-business</i>		Medium	2	Medium
Small scale production of quality processed roots and tubers is inadequate	Development of technology for small scale production of processed roots and tubers – <i>leading to establishment of small scale root and tuber processing industry as an Agri-business</i>		Medium	2	Short
Protected farming for high value root and tuber crop production is inadequate	Development of protected farming models for high value root and tuber crop production – <i>leading to development of protected high value root and tuber crop farming as an Agri-business</i>		Low	3	Medium
Supply of organic farm produced root and tuber crop is limited	Development of technology for production of root and tuber crops in organic farming system – <i>leading to development of organic vegetable production as an Agri-business</i>		Low	3	Medium
The period of availability of some root and tuber crops in the market is very short	Development of technology for short term storage of root and tuber crops in small scale – <i>leading to development of small scale root and tuber storage industry as an Agri-business</i>		Medium	2	Medium
Supply of high quality planting materials of root and tuber crops is limited	Development of technology for production of high quality planting materials of root and tuber crops on contract basis – <i>leading to contract growing of high quality planting materials of root and tuber crops as an Agri-business</i>		Medium	2	Medium

7d.a. SPICES : VARIETY DEVELOPMENT AND CONSERVATION OF PLANT GENETIC RESOURCES

Research Area		<i>Horticultural Crops</i>			
Sub-Area		<i>Spices</i>			
Research Agenda / Thematic Area		<i>Variety Development and Conservation of Plant Genetic Resources</i>			
Problem/ Constraints	Research Title/ Key Words	%of benefic.	Prob. of success	Prior. rank	Res. Tenure
Erosion of local genetic resources of spice crops	Collection, evaluation and conservation (seed and <i>in-vitro</i>) of local germplasm / landraces of spice crops		High	1	Long
Not enough good quality and high yielding varieties of major / important spice crops	Development of improved varieties (high yielding as well as good quality) of major / important spice crops through selection from local material, introduction and hybridization		High	1	Long
Hybrid varieties of spice crops not yet developed in the country	Development of hybrid varieties of important spice crops (namely, chilli and onion) and maintenance of parent lines		Medium	2	Long
Varietal characters of registered / released varieties of spices not well-documented	Morphological and molecular characterization of registered / released varieties of spice crops		High	1	Medium
High incidence of disease and insect pests	Development of disease and insect tolerant / resistant varieties of spice crops through conventional and modern techniques of breeding		Medium	1	Long
Varieties for specific purposes are not available	Development of varieties for specific purposes (e.g., processing and export)		Medium	2	Long
Some registered / released varieties are not popular	Socio-economic study / survey study on acceptability of registered / released varieties of spice crops		High	1	Short
Degeneration of registered / released varieties of spice crops	Purification of degenerated varieties of spice crops		High	2	Medium
Poor performance of some spice crops in high density planting	Development of varieties of spice crops suitable for high density planting		Medium	2	Medium
Poor performance of spice crops in saline areas	Development of varieties of spice crops suitable for saline areas		Medium	1	Long
Seasonality in production	Development of early, medium and late varieties of spice crops, as well as varieties suitable for off-season production		Medium	2	Medium

7d.b. SPICES : PRODUCTION TECHNOLOGY

Research Area		<i>Horticultural Crops</i>			
Sub-Area		<i>Spices</i>			
Research Agenda / Thematic Area		<i>Production Technology</i>			
Problems / Constraints	Research Title / Key Words	% of benefic.	Prob. of success	Prio. rank	Res. Tenure
Recommendations on manure and fertilizer application for spice crops do not perform well	Standardization of dose and method of application of manures and fertilizers for different spice crops		High	1	Medium
Recommendations for intercropping and mixed cropping are not well-tested	Study on intercropping and mixed cropping in different spice crops		High	2	Medium
Loss due to major insect pests is high in some spices	Management of major insect pests of important spice crops		Medium	2	Medium
Loss due to major diseases is high in some spice crops	Management of major diseases of important spice crops		Medium	2	Medium
Poor yield and quality of spices due to water stress	Study on water requirement, irrigation technique and use of mulch in spice crop production		Medium	1	Medium
Most spice crops are not grown throughout the year	Development of technology for off-season, year round and lean season production of spice crops		Medium	2	Medium
Impact of developed production technologies not known	Socio-economic study on the impact of improved technologies on spice crop production		High	1	Short
Quality of produced spices for export and processing is not very good	Development of technology for processing and export oriented production of spice crops		High	1	Medium
Poor economic return in the production of some spice crops	Study of different levels of input use and manipulation of production technology on yield and economic return from different spice crops		Medium	1	Medium
Inadequate high tech production technologies	Development of cost-effective high tech production technologies particularly for high value spices		Medium	2	Short
Lack of production technology for growing spice crops in hilly regions	Development of appropriate production technologies for growing different spice crops in hilly regions		Medium	2	Medium
Lack of appropriate technologies for growing spices in saline areas	Development of appropriate production technologies for growing different spice crops in saline areas		Medium	1	Medium
Technologies for production of spice crops in Bill, Haor and Charland, areas are inadequate	Development of appropriate technologies for production of different spice crops in Bill, Haor and Charlands areas		High	1	Medium

7d.c. SPICES : SEED AND QUALITY PLANTING MATERIAL

Research Area		Horticultural Crops			
Sub-Area		Spices			
Research Agenda / Thematic Area		Seed and Quality Planting Material			
Problems / Constraints	Research Title / Key Words	% of benefic.	Prob. of success	Prio. rank	Res. tenure
Quality seeds of registered / released op varieties of spices not available	Development of technology for quality seed production of registered / released op varieties of spices		High	1	Medium
Quality seeds of registered / released hybrid varieties of spices not available	Development of technology for quality seed production of registered / released hybrid varieties of spices; and maintenance of parent lines		High	1	Medium
Quality and yield of breeders', foundation, certified and TL seeds of spice crops not adequate	Improvement of technology for production of breeders', foundation, certified and TL seeds of different spice crops		High	1	Medium
Seeds of spice crops retained at farmers' house generally do not perform well	Development of technology for better storage of seeds of spice crops at farmers' level		High	1	Medium
Spice crop growers are not able to judge the quality of their own as well as procured seeds	Development of easy techniques for judging the quality of seeds of different spice crops at farmers' level		High	1	Short
Quality planting materials of asexually propagated spice crops not adequate	Development of technology for production of high quality planting materials of asexually propagated spice crops, namely, ginger, turmeric and garlic		High	1	Medium

7d.d. SPICES : POST-HARVEST MANAGEMENT

Research Area		Horticultural Crops			
Sub-Area		Spices			
Research Agenda / Thematic Area		Post-harvest Management			
Problems / Constraints	Research Title / Key Words	% of benefic.	Prob. of success	Prio. rank	Res. tenure
Maturity indices for different spice crops not well-defined	Standardization of maturity indices for different spice crops, specific to use		High	1	Medium
Post-harvest handling practices for different spice crops not well-defined	Standardization of post-harvest handling practices for different spice crops		High	1	Short

Techniques of value addition for different spices are not known	Development of value addition techniques for different spices as per market demand		Medium	2	Short
Estimates of post-harvest losses of different spices are not precise	Study on post-harvest losses of spices (quantitative) at different stages of marketing		Medium	1	Medium
Post-harvest losses of different spices are high	Development of pre-harvest, harvest and post-harvest techniques for minimizing post-harvest loss of different spices		High	1	Medium
Post-harvest deterioration in quality of spices is not known	Estimation and control of post-harvest deterioration in quality of spices		Medium	2	Medium
Extensive use of pesticides in spice crops leading to human health hazard	Estimation of pesticide residues in harvested spices in relation to dose and method of fungicides and insecticide application		Medium	2	Medium
Post-harvest loss in quality of spices due to microbial contamination	Control of post-harvest loss in quality of spices through reduction of microbial contamination		Medium	2	Medium
There is no standard of product quality for spices	Development of standard of product quality for spices		High	2	Short
Poor shelf life of some spices	Extension of shelf life of spices through environment friendly and human health hazard-free techniques		Medium	2	Medium
Some spices are perishable, and cannot be stored long under ordinary conditions	Development of technology for short term storage of perishable spices		Medium	2	Medium
Marketing system of spices is not defined and poor	Market research leading to improvement in the marketing of spices		High	1	Medium

7d.e. SPICES : AGRI-BUSINESS IN HORTICULTURE

Research Area		Horticultural Crops			
Sub-Area		Spices			
Research Agenda / Thematic Area		Agri-business in Horticulture			
Problem / Constraints	Research Title / Key Words	% of benefic.	Prob. of success	Prio. rank	Res. tenure
Production of quality packaging materials and containers for marketing of spices not adequate	Development of standard packaging materials and containers for marketing of spices – leading to development of packaging industry for spices as an Agri-business		Medium	2	Medium
The quantity of spice exported per year from Bangladesh is very small	Development of technology for contract growing of export quality spices – leading to development of export oriented contract growing of spice crops as an Agri-business		Medium	2	Medium

Quality of locally produced spices often do not fulfill the requirements of processing industries	Development of technology for contract growing of processing quality spices – leading to development of contract growing of processing quality spices as an Agri-business		High	1	Medium
Small scale production of quality processed spice is inadequate	Development of technology for small scale production of processed spices – leading to development of small scale processing industry for spices as an Agri-business		Medium	2	Short
Protected farming for high value spice crop production is lacking	Development of protected farming models for high value spice crop production – leading to development of protected high value spice crop farming industry as an Agri-business		Low	3	Medium
Supply of organic farm produced spice is lacking	Development of technology for production of spice crops in organic farming system – leading to development of organic spice crop production farm as an Agri-business		Low	3	Medium
Period of supply of some locally produced spices in the market is short	Development of technology for short term storage of perishable spices in small scale – leading to development of small scale storage of perishable spices as an Agri-business		Medium	2	Medium
Supply of high quality seed / planting materials of spice crops is limited	Development of technology for production of high quality seed / planting materials of spice crops on contract basis – leading to production of high quality seed / planting materials of spice crops on contract basis as an Agri-business		Medium	2	Medium

7e.a. FLOWERS AND ORNAMENTALS : VARIETY DEVELOPMENT AND CONSERVATION OF PLANT GENETIC RESOURCES

Research Area		Horticultural Crops			
Sub-Area		Flowers and Ornamentals			
Research Agenda / Thematic Area		Variety Development and Conservation of Plant Genetic Resources			
Problem/ Constraints	Research Title/ Key Words	%of benefic.	Prob. of success	Prior. rank	Res. Tenure
Erosion of local genetic resources of flowers and ornamentals	Collection, evaluation and conservation (seed and <i>in-vitro</i>) of local germplasm / landraces of flowers and ornamentals		High	1	Long

Not many good varieties of major / important flowers and ornamentals	Development of improved varieties of major / important flowers and ornamentals through selection from local material, introduction and hybridization where possible		High	1	Long
Varietal characters of registered / released varieties not well-documented	Morphological and molecular characterization of registered / released varieties of flowers and ornamentals		High	1	Medium
High incidence of disease and insect pests	Development of disease and insect tolerant / resistant varieties of flowers and ornamentals through conventional and modern techniques of breeding		Medium	2	Long
Poor performance of some flowers and ornamentals in saline areas	Development of varieties of flowers and ornamentals suitable for saline areas		Medium	3	Long

7e.b. FLOWERS AND ORNAMENTALS : PRODUCTION TECHNOLOGY

Research Area		Horticultural Crops			
Sub-Area		Flowers and Ornamentals			
Research Agenda / Thematic Area		Production Technology			
Problems / Constraints	Research Title / Key Words	% of benefic.	Prob. of success	Prio. rank	Res. Tenure
Recommendations on manure and fertilizer application do not perform well	Standardization of dose and method of application of manures and fertilizers for different flowers and ornamentals		High	1	Medium
Appropriate recommendations for practices like pruning and training not available	Development of pruning and training practices specific to varieties of flowers and ornamentals		Medium	2	Medium
Loss due to attack of some major insect pests is high in some flowers and ornamentals	Management of major insect pests of important flowers and ornamentals		Medium	2	Medium
Loss due to some major diseases is high in some flowers and ornamentals	Management of major diseases of important flower and ornamental crops		Medium	2	Medium
Poor yield and quality of flowers and ornamentals due to water stress	Study on water requirement, irrigation technique and use of mulch in production of flowers and ornamentals		Medium	1	Medium
Some flowers and ornamentals are not uniformly available throughout the year	Development of technology for off-season, year round and lean season production of flowers and ornamentals		Medium	2	Medium
Impact of developed production technologies not known	Socio-economic study on the impact of improved technologies on production of flowers and ornamentals		Medium	2	Short

Quality of flowers and ornamentals for export is not high	Development of technology for export oriented production of flowers and ornamentals		Medium	2	Medium
Technology for use of growth regulating chemicals in flower production is not known	Study on dose and method of application of growth regulating chemicals in the production of different flower crops		Medium	2	Short
Poor economic return in the production of some flowers and ornamentals	Study of different levels of input use and manipulation of production technology on yield and economic return from different flowers and ornamentals		High	1	Medium
Inadequate high tech production technologies	Development of cost-effective high tech production technologies particularly for high value flower and ornamental crops		Medium	2	Short
Inadequate production technology for growing flowers and ornamentals in hilly regions	Development of appropriate production technologies for growing flowers and ornamentals in hilly regions		Medium	2	Medium
Appropriate technologies for growing flowers and ornamentals in saline areas are lacking	Development of appropriate production technologies for growing flowers and ornamentals in saline areas		Medium	3	Medium

7e.c. FLOWERS AND ORNAMENTALS : SEED AND QUALITY PLANTING MATERIAL

Research Area		Horticultural Crops			
Sub-Area		Flowers and Ornamentals			
Research Agenda / Thematic Area		Seed and Quality Planting Material			
Problems / Constraints	Research Title / Key Words	% of benefic.	Prob. of success	Prio. rank	Res. tenure
Quality seeds / planting materials of registered / released varieties of flowers and ornamentals not available	Development of technology for production of quality seed / planting material of registered / released varieties of flowers and ornamentals		High	1	Medium
Flower seeds retained at farmers' house generally do not perform well	Development of technology for better storage of flower seeds at farmers' level		Medium	2	Medium
Flower growers are not able to judge the quality of their own as well as procured seeds	Development of easy techniques for judging the quality of flower seeds at farmers' level		Medium	2	Short

7e.d. FLOWERS AND ORNAMENTALS : POST-HARVEST MANAGEMENT

Research Area		<i>Horticultural Crops</i>			
Sub-Area		<i>Flowers and Ornamentals</i>			
Research Agenda / Thematic Area		<i>Post-harvest Management</i>			
Problems / Constraints	Research Title / Key Words	% of benefic.	Prob. of success	Prio. rank	Res. tenure
Maturity indices for different flowers not well-defined	Standardization of maturity indices for different flowers, specific to use		High	1	Medium
Post-harvest handling techniques for different flowers not well-defined	Standardization of post-harvest handling practices for different flowers		High	1	Short
Techniques of value addition for different flowers and ornamentals are not known	Development of value addition techniques for different flowers and ornamentals as per market demand		Medium	2	Short
Estimates of post-harvest losses of different flowers are not precise	Study on post-harvest losses of flowers (quantitative) at different stages of marketing		Medium	1	Medium
Post-harvest losses of different flowers are high	Development of pre-harvest, harvest and post-harvest techniques for minimizing post-harvest loss of different flowers		High	1	Medium
Post-harvest deterioration in quality of flowers is not known	Estimation and control of post-harvest deterioration in quality of flowers		Medium	2	Medium
Extensive use of pesticides in flower crops leading to human health hazard	Estimation of pesticide residues in harvested flowers in relation to dose and method of application of insecticides and fungicides		Medium	2	Medium
Post-harvest loss in quality of flowers due to microbial contamination	Control of post-harvest loss in quality of flowers through reduction of microbial contamination		Medium	2	Medium
There is no standard of product quality for flowers	Development of standards in product quality of flowers		Medium	2	Short
Poor vase life of flowers	Extension of vase life of flowers through use of environment friendly and human health hazard-free techniques		Medium	2	Medium
Flowers are perishable, and cannot be stored under ordinary conditions	Development of technology for short term storage of flowers		Medium	2	Medium
Marketing system of flowers and ornamentals is not defined and poor	Market research leading to improvement in the marketing of flowers and ornamentals		High	1	Medium

7e.e. FLOWERS AND ORNAMENTALS : AGRI-BUSINESS IN HORTICULTURE

Research Area		<i>Horticultural Crops</i>			
Sub-Area		<i>Flowers and Ornamentals</i>			
Research Agenda / Thematic Area		<i>Agri-business in Horticulture</i>			
Problem / Constraints	Research Title / Key Words	% of benefic.	Prob. of success	Prio. rank	Res. tenure
Production of quality packaging materials and containers for marketing of vegetables not adequate	Development of standard packaging materials and containers for marketing of flowers and ornamentals – leading to establishment of packaging material industry as an Agri-business		High	2	Medium
The quantity of flowers and ornamentals exported from Bangladesh per year is very small	Development of technology for contract growing of export quality flowers and ornamentals – leading to development of contract growing of flowers and ornamentals for export as an Agri-business		Medium	2	Medium
Protected farming for high value flower and ornamental crop production is inadequate	Development of protected farming models for high value flower and ornamental crop production – leading to development of protected high value flower and ornamental farming industry as an Agri-business		Low	3	Medium
Supply of high quality seed / planting material of flowers and ornamentals is limited	Development of technology for production of high quality seed / planting material of flowers and ornamentals on contract basis – leading to production of high quality seed / planting material of flowers and ornamentals as an Agri-business		High	1	Medium
Supply of potted ornamental plants (on hire basis) for decoration is limited	Improvement of technology for growing and management of indoor and out-door ornamental plants in pots – leading to development of Agri-business on hiring out of potted ornamentals for decoration		High	1	Medium

8. Constraints and Limitations

As evident from the annual reports of HRC, TCRC, SRC and other publications, there has been a very little progress in research on horticultural crops in Bangladesh during the recent past. There was a significant progress in research on fruits, vegetables and root and tuber crops during early 80's to mid 90's, which became gradually laggard and stereotypic at later stages. Systematic research on spice crops has just started after the establishment of SRC. Research on flowers and ornamentals, in true sense, has not yet been started in Bangladesh (Rashid, 2010). While stating about research needs on horticultural crops, Dr. Kamal Uddin Ahmad has indicated that the present

research in the area of horticulture is so much in the doldrums that no amount of listing or prioritizing would address the true requirement (Ahmad, 2010). According to him, there is a serious need for over-hauling. Obviously, there are reasons for such staggered ness .in present horticultural research. The prevailing constraints and limitations in horticultural research, as listed below, explain the reasons to a great extent.

-The number of crops in the horticulture sub-sector, comprising fruits, vegetables, roots & tubers, spices and flowers & ornamentals would be several hundreds; and many of which deserve research attention.

-The data on area, production and yield of horticultural crops available from different sources (BBS, DAE, FAO) vary widely, and are often far from the actual. Planning of research based on such data leads to misleading findings.

-Facilities for horticultural research developed in Bangladesh during the last few decades, particularly in respect of land, laboratory and equipment, are remarkable. But, there had been a simultaneous depletion in the number of efficient horticultural scientific personnel in the country, mainly due to (i) migration of qualified and experienced scientific persons to other countries, (ii) transfer of scientific personnel to positions not in their field of expertise and (iii) recruitment of efficient scientific personnel by international agencies, donor-funded projects, private companies and NGOs. As a matter of fact, in a number of well-equipped laboratories of BARI, there is not many skilled manpower to operate the existing sophisticated equipment or to carry out laboratory based research efficiently.

On the other hand, leadership in research on fruits, vegetables, roots & tubers, spices and flowers & ornamentals has almost collapsed. A good leadership cannot be expected, when senior level scientific persons (e.g., CSO / Director) retire or are transferred only after few months of taking over of charge. In addition, placement of senior level scientific persons in positions like, CSO / Director of HRC or TCRC, having no experience or expertise in the relevant field, has aggravated the situation further. At the same time, the manpower development programs of different organizations (particularly of BARI) could not contribute much to horticultural research due to lack of incentive for the concerned scientists, unrest ness in management and deterioration in research environment.

-Undue lobbying and interference of internal and external influential persons / groups in recruitment, promotion and transfer of scientific persons often result frustration among the sincere and dedicated research workers.

-The present GO-NGO, GO-Private, NGO-Private, Private-Private collaboration and co-operation in matters related to horticulture are either very weak or not effective. The activities of NGOs and private companies are often not supportive to public sector research.

-The scientific persons based particularly in the remote research stations have little or no access to recent literature and internet facilities, and do not get

the supply of research inputs and laboratory equipment as and when needed. Often they do not get adequate guidance for carrying out the researches under their annual programs, and conduct the experiments without much direction and understanding (Ahmad, 2010).

-Existing weaknesses in import and other policies of the government often lead to indiscriminate import of vegetable seeds, seed potatoes, fresh fruits, spices, ornamental plants and flowers in the country, which create problems in setting research objectives and in research planning.

-Since the reputed agricultural universities of Bangladesh are not under the umbrella of NARS, there had been a very little scope for coordinated and collaborative research in the field of horticulture. Also that, the outstanding research findings, generated at the universities, are not being properly utilized at the national level.

9. Conclusions and Recommendations

In October 2009, the Bangladesh Agricultural Research Council (BARC) constituted 12 Expert Teams for carrying out studies on prioritization of research in 12 sub-sectors of agriculture leading to preparation of a document on "Agricultural Research Vision 2030 and Beyond". As per the ToR of Team Leaders, the "Horticultural Crops Sub-sector" comprised of Fruits, Vegetables, Roots & Tubers, Spices and Flowers & Ornamentals.

The Horticultural Crops Group co-opted 4 members in the Group, discussed with the resource persons, conducted consultation meetings at BARI, BAU and BARC and prepared a draft report on "Prioritization of Research for Horticultural Crops" in January 2010. The draft report contained the background of the study, activities performed by the Group, status of the Horticultural Crops Sub-sector and lists of research needs in horticultural crops under the selected 5 thematic areas. The selected thematic areas are, (i) variety development and conservation of plant genetic resources, (ii) production technology, (iii) seed and quality planting material, (iv) post-harvest management and (v) agri-business in horticulture.

The draft report was presented in the BARC organized workshop on 08/03/2010 in presence of senior level officials / resource persons of BARC, BARI, BRRI, BAU, BSMRAU, SAU, KGF, DAE, DAM, BADC and BINA. The participants of the workshop discussed the draft report critically, and gave suggestions for improvement.

The comments and suggestions of the resource persons and participants of the group consultation meetings and BARC organized workshop and feedback obtained from the regional workshops were considered in finalizing the report. In the final report an Executive Summary, ToR of the Group Leader and notes on Prioritization of Crops for Horticultural Research, Constraints & Limitations and Conclusions & Recommendations have been included.

Necessary correction and improvement in the text of the draft report have also been made.

In brief, the identified and listed major research topics in the selected 5 thematic areas for fruits, vegetables, roots & tubers, spices and flowers and ornamentals are as follows :

1. Variety Development and Conservation of Plant Genetic Resources

- Collection, characterization, evaluation & conservation of local & exotic germplasm
- Development of improved high yielding and good quality varieties
- Development of insect and disease resistant varieties using modern techniques
- Development of specific purpose varieties (e.g. for processing, export)
- Dev. of varieties suitable for high density planting and for saline and hilly areas
- Development of early, medium and late maturing varieties
- Development of hybrid varieties for important horticultural crops
- Morphological and molecular characterization of recommended / released varieties
- Purification of degenerated varieties
- Socio-economic study on acceptability of recommended / released varieties

2. Production Technology

- Standardization of dose and method of application of manures and fertilizers
- Development of technology for high density planting
- Development of training, pruning and fruit thinning practices for important fruit crops
- Study on intercropping in horticultural crops
- Study on utilization and management of orchard lands
- Management of major insect pests and diseases of important horticultural crops
- Study on water requirement, irrigation technique and use of cover mulch
- Development of off-season, year-round and lean-season production technology
- Development of technology for processing and export oriented production
- Study on use of growth regulators for flower induction, fruit set and fruit retention
- Development of high-tech production technology for high value horticultural crops
- Dev. of tech. for growing horticultural crops in hills, saline areas and homesteads
- Economizing input use, and manipulation of prod. tech. for high economic return
- Socio-economic study on acceptability and impact of recommended technology

3. Seed and Quality Planting Material

- Dev. of veget. propagation tech. for difficult to propagate fruit and ornamental plants
- Search of root-stocks suitable for growing hort. crops in hills and saline areas
- Study on production of high quality root-stocks for grafting and budding operations
- Improv. of *in-vitro* propagation tech. and rapid multiplication of different hort. crops
- Studies on prod. of disease-free planting materials using tissue culture techniques
- Improvement of management practices for the saplings maintained in nurseries
- Dev. of veg. propagation and top-working techniques suitable for jackfruit and litchi
- Study on pre-planting treatment and management of pineapple and banana suckers
- Study on prod. & quality of planting materials of veg. prop. Veget., spices & flowers
- Improv. of tech. for quality seed prod. of both op and hybrid varieties of hort. crops
- Dev. of technology for improvement of the quality of farmers' planting materials
- Development of technology for better storage of true seeds at farmers' level

4. Post-harvest Management

- Standardization of maturity indices for different hort. crops in relation to utilization
- Standardization of post-harvest handling techniques for different horticultural crops
- Study on value addition techniques for different horticultural products
- Study on post-harvest losses of different horticultural products during marketing
- Study on minimizing post-harvest losses through pre- and post-harvest techniques
- Study on deterioration in quality of harvested products: estimation, causes, control
- Dev. of safe tech. for ripening of fruits, and extending shelf life of hort. products
- Study on safe use of agro-chems. in harvested products in relation to health hazard
- Dev. of standards for product quality of fresh horticultural products
- Market research leading to improvement in marketing of horticultural products
- Dev. of technology for short term preservation / storage of hort. products

5. Agri-business in Horticulture

Research is needed for development of the following Agri-businesses :

- Production of standard packaging materials for marketing of horticultural products
- Contract growing of fruits, vegetables and spices for processing industries
- Contract growing of veg., roots& tubers, spices and flowers & ornamentals for export
- Hiring out of potted ornamental plants for indoor and outdoor decoration
- Planning, establishment and management of ornamental gardens on contract basis
- Prod. of earthen, metal, glass & ceramic pots, containers and vases for ornamentals
- Contractual spraying of pesticides and growth reg. in fruit orchards and crop fields
- Commercial utilization of the by-products of horticultural crops
- Value addition and marketing of locally produced horticultural products
- Small scale production and marketing of processed fruits and vegetables
- Production of high value horticultural crops under protected farming system
- Production of fruits and vegetables in organic farming system
- Small scale short-term storage of fruits
- Prod. and marketing of high quality saplings and planting materials of hort. crops
- Contract growing of high quality op and hybrid seeds of horticultural crops

As mentioned under the “Constraints and Limitations” part of this report, there has been a very little progress in research on horticultural crops in Bangladesh during the recent past. The identified major constraints and limitations for the present stagnation in horticultural research are as follows

- too many crops under the horticulture sub-sector, and shortage of efficient scientific manpower to address the problems of so many crops of diverse nature;
- the data on area, production and yield of horticultural crops available from different sources are often misleading and far from reality ;
- leadership in horticultural research has almost collapsed mainly due to retirement and frequent transfer of senior level personnel within a few months of their placement
- the activities of NGOs and private companies in matters related to horticulture are often not congenial and supportive to public sector research ;

-the remote research stations do not have adequate facility for research ; and there is little scope for the scientific persons of those stations for developing their own scientific and research ability ;

-indiscriminate import of vegetable seeds, seed potatoes, fresh fruits, spices, ornamental plants and flowers in the country creates problems in setting research objectives and in research planning ;

-the reputed agricultural universities of Bangladesh are not under NARS, and most of their outstanding research findings and out-puts are not being properly utilized at the national level. Research collaboration between NARS institutes and universities is also very insignificant due to the stated reason.

Recommendations

In addition to the research priorities for fruits, vegetables, roots & tubers, spices and flowers & ornamentals, presented under the selected 5 thematic areas, the following recommendations should be considered in preparing the document on “Agricultural Research Vision 2030 and Beyond” :

1.The annual production of fruits, vegetables, roots & tubers and spices in Bangladesh should be increased during the next decades at least at the rate of population growth. Since the data on area, production and yield of most of the horticultural crops, available from different sources (BBS, DAE, FAO), are apparently misleading and far from reality, there is a need for making an alternative arrangement of collecting reliable data.

2.Export of selected fruits, vegetables, root and tuber crops (including potatoes), flowers and ornamentals should be encouraged through export oriented production, development of export facilities and allocation of cash incentive.

3.Indiscriminate import of horticultural products, like, fruits, vegetables, seed potatoes, spices, cut flowers and ornamentals should be discouraged ; and smuggling in of those items should be checked.

4.Processing of selected fruits, vegetables, potatoes and spices should be encouraged through processing oriented production of raw materials, development of processing and marketing (both local and international) facilities and technical support. Steps should be taken to bring the established 4 potato flakes/starch industries into regular operation.

5.Since there is a huge number of crops of variable importance under the horticulture sub-sector, prioritization of crops under fruits, vegetables, roots & tubers, spices and flowers & ornamentals for research is needed. Prioritization of crops should be based on importance, market demand, nutritional value and potentials for crop improvement, commercial production, processing and export. Low value horticultural crops should be gradually phased-out from commercial production.

6.In order to reduce pressure on cereal food crops, steps should be taken for increasing the per-capita consumption of vegetables and root & tuber crops.

7.Research should be strengthened for increasing the productivity of important horticultural crops through improvement of variety and manipulation of production

practices. Productivity of crops should, however, be expressed in terms of value of crop produced / unit area and per unit time instead of yield / unit area.

8.High investment in research for low value and less important crops should be avoided. Suitability of a research program for funding should be judged on clear objectives, probability of success, economic importance and scope for commercial utilization of the findings. Fancy, eye-washing and stunting research programs with little scientific merit and economic importance should not be considered for any support.

9.Research for improved production of horticultural crops in hills, saline areas and Char lands should be encouraged.

10.Funding to NGOs, private organizations and individual researchers for horticultural research / R&D programs by different agencies (e.g., BARC, NATP, KGF, Ministry of Science & Technology, Donor Supported Projects, International Organizations) should be strongly judged. Only the most important and standard Project Proposals submitted by NGOs / Private Organizations / Individual Researchers having adequate knowledge, research background, required facilities and efficient manpower should be considered for funding.

11.Policies should be undertaken for the development of efficient scientific manpower and leadership in horticultural research.

12.The reputed Agricultural Universities of Bangladesh should be brought under the umbrella of NARS.

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