ADB

Technical Assistance Report

Project Number: 47166
Research and Development Technical Assistance (RDTA)
December 2013

Islamic Republic of Pakistan: Punjab Basmati Rice Value Chain

Asian Development Bank

CURRENCY EQUIVALENTS

(as of 2 December 2013)

Currency unit	–	Pakistan rupee(s) (PRe/PRs)
PRe1.00	=	$0.0092
$1.00	=	PRs108.48

ABBREVIATIONS

ADB	–	Asian Development Bank
BLB	–	bacterial leaf blight
IRRI	–	International Rice Research Institute
PARB	–	Punjab Agricultural Research Board
PARC	–	Pakistan Agricultural Research Council
R&D	–	research and development
TA	–	technical assistance

TECHNICAL ASSISTANCE CLASSIFICATION

Type	–	Research and development technical assistance (RDTA)
Targeting classification	–	General intervention
Sector (subsector)	–	Agriculture and natural resources (agricultural production and markets)
Theme (subthemes)	–	**Economic growth** (widening access to markets and economic opportunities), private sector development (promotion of private sector investment), capacity development (client relations, network, and partnership development)
Location (impact)	–	Rural (high), national (medium), urban (medium), regional (low)

NOTE

(i) The fiscal year (FY) of the Government of Pakistan and its agencies ends on 30 June. “FY” before a calendar year denotes the year in which the fiscal year ends, e.g., FY2013 ends on 30 June 2013.

(ii) In this report, "$" refers to US dollars.

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CONTENTS

I. INTRODUCTION

1. The Punjab public and private agriculture research institutions, basmati rice farmers, traders and exporters, and the International Rice Research Institute (IRRI) asked the Asian Development Bank (ADB) for technical assistance (TA) to pilot innovations on improving basmati seed variety and developing value chain with private sector participation and links of farmers to processing and markets. Punjab, Pakistan's global comparative edge in basmati production and export is fast eroding due to the poor performance of the upstream and midstream segments of the basmati rice value chain. ADB fielded a TA consultation mission during 26 February–5 March 2013 to identify key challenges and opportunities, and a fact-finding mission during 18–23 August 2013 to finalize the TA design and implementation arrangements. The government concurred with the TA impact, outcome, outputs, implementation and financing arrangements, and terms of reference. The TA design and monitoring framework is in Appendix 1. [1]

II. ISSUES

2. Rice is the third largest crop in Pakistan after wheat and cotton. Rice production on average accounted for 4.4% of agriculture value added and 1% of gross domestic product. It is grown on about 2.5 million hectares, or 10% of annual cropped area, for an annual production of about 6.15 million tons.[2] Pakistan ranks 13th in rice production and fourth in rice exports in the world. During fiscal year 2013, its rice exports of 3.1 million tons have earned about $1.9 billion.[3]

3. Basmati rice—famous for its aroma, long grain size, and high cooking and eating quality—is a leading foreign exchange earner of Pakistan, which accounts for more than two-thirds of the world's basmati production.[4] Basmati is grown mainly in Punjab, and in fiscal year 2012, 65% of Punjab's total rice area, or 1.1 million hectares, was devoted to basmati, producing about 2 million tons.

4. Pakistan's competitive edge in the basmati world market, however, has been eroding in recent years because of productivity and quality constraints. Although Pakistan has historically been the world's leading supplier of basmati rice, from July–December 2012, basmati exports declined by 31% (from 349,970 tons to 239,765 tons) compared to the same period in previous years. This decline came after India lifted a ban on its rice exports in 2012 and sold the commodity at a price lower than Pakistan: about $100 cheaper per ton against Pakistan's $1,100–$1,150 per ton due to its higher yield and more diverse varieties.[5] Meanwhile, demand for basmati has been increasing worldwide. Pakistan's basmati value chain therefore needs to be strengthened to meet rising international demand and maintain its status as the world's leading supplier of basmati rice.

5. The major bottleneck in Pakistan's basmati value chain is at the upstream segment, or farm production. High production costs and declining yield of current basmati varieties make its cultivation a less profitable venture for Punjab rice farmers, resulting in some farmers shifting to other varieties for better yields. Key constraints of basmati farm production are the following:

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[1] The TA first appeared in the business opportunities section of ADB's website on 30 August 2013.

[2] S. Nazeer, A. U. Malik, G. Nazir, and J. Ahmad. 2012. Effectiveness of Tillage Systems and Farm Manure Levels on Rice Productivity. *The Journal of Animal & Plant Sciences.* 22 (2). Page: 334-338.

[3] Trade Development Authority of Pakistan. 2013. *Exports From Pakistan – Final Statistics (July-June 2012-13).* Karachi.

[4] E. A. Siddiq, L. R. Vemireddy, and J. Nagaraju. 2012. Basmati Rices: Genetics, Breeding and Trade. *Agriculture Research.* 1 (1). Page: 25–36.

[5] Business Monitor International Ltd. 2013. *Mild Export Growth Amidst Growing International Competition.* London.

(i) **Limited basmati varieties**. Compared to Indian farmers, who have access to several high-yielding basmati varieties, Pakistani farmers have access to and cultivate mainly one variety, Super Basmati, which was introduced in 1996 and is grown in 70% of the total basmati area in Punjab. Basmati 515, an improved variety, was introduced in 2011, but its adoption has been slow as farmers have limited access to certified seeds and proper training for its production. Both Super Basmati and Basmati 515 are neither resistant to bacterial leaf blight (BLB) nor tolerant of extended dry spells, which occur increasingly in basmati growing areas.

(ii) **Inadequate research and development funds**. The Punjab Agricultural Research Board (PARB) allocates funds for research and development (R&D) relevant to the province's agriculture sector. The PARB's role has significantly improved R&D administration, management, and coordination among all institutions involved. However, the PARB's annual R&D budget of about PRs180 million remains modest given the size and requirement of Punjab's agriculture. The Rice Research Institute at Kalashah Kaku, the leading institution on rice development in the province, has a meager annual budget of PRs30 million. Because of this resource constraint, Punjab's agriculture R&D remains significantly underfunded.

(iii) **On-farm challenges**. Basmati farmers face a number of production constraints, such as lack of access to certified seed; low plant population (an average of 125,000 plants/hectare against the recommended 200,000); BLB; input supply quality and quantity; labor shortage during transplanting and harvesting; unavailability or inappropriate types of combined harvesters that result in a 3%–7% loss of paddy; high moisture content at harvesting (more than 30% compared to the desired 20%–22% at harvest and 12%–14% for storage); lack of sufficient mechanical drying and storage facilities, contributing to aflatoxin growth; and poor extension services. These constraints result in an average basmati paddy yield of about 2.4 tons/hectare, compared to about 3.2 tons/hectare in India. Given the potential yield of current basmati varieties, average paddy yield could be more than 3 tons/hectare if most constraints are addressed.

6. Overcoming the major problems affecting Punjab's basmati rice production is urgently needed for Pakistan to regain and sustain its competitiveness in the world market, improve the subsector's foreign exchange earnings, and ensure higher incomes for basmati farmers and other stakeholders in the value chain. The TA will focus on measures that meet the following criteria: (i) tangible results achievable within 2–3 years; (ii) complementing and adding value to ongoing activities of public and private sector stakeholders; and (iii) having the potential to significantly increase the yields of basmati rice, improve the efficiency of the upstream segment of the basmati value chain, and integrate the upstream segment more effectively with the midstream and downstream segments of the value chain.

7. The TA supports Pakistan's and Punjab's development priorities and is consistent with ADB's country partnership strategy, 2009–2013, which supports government efforts for sustained economic growth and poverty reduction by increasing productivity and competitiveness in key sectors, including agriculture.[6] ADB's country operations business plan, 2013–2014, continues the country partnership strategy focus of more efficient and productive irrigation and more reliable water resources, with corresponding reforms to improve the performance of the agriculture sector.[7] Linked to this is continued enhancement of public–private partnerships to support the government's strategy for private sector development, increased competitiveness, and structural change. The government's growth strategy is focused

[6] ADB. 2009. *Country Partnership Strategy: Pakistan, 2009–2013.* Manila.
[7] ADB. 2013. *Country Operations Business Plan: Pakistan, 2013–2014.* Manila.

on accelerating and sustaining economic growth through fundamental economic reforms and enhancing productivity in key sectors. The agriculture sector focus of Punjab's Medium Term Development Framework 2012–2015 and Development Programme 2012–2013 centers on food security and the promotion of exportable high-value crops, with an emphasis on sustained productivity improvement in wheat and rice by encouraging public sector research and collaboration.[8]

8. The TA is consistent with ADB's Operational Plan for Sustainable Food Security on increasing synergy and value addition in backward and forward linkages along the food and agriculture value chain.[9] The TA will directly complement ADB's investments in Punjab, such as the Punjab Irrigated Agriculture Investment Program, which rehabilitates key irrigation infrastructure in Punjab and benefits farm families who derive their livelihoods directly from crops grown in the command area, such as wheat, rice, and maize.[10] The command areas of tranches 1–3 of the Punjab Irrigated Agriculture Investment Program overlap with basmati growing areas such as Faisalabad, Gujranwala, Hafizabad, Jhang, Nankana Sahib, Okara, Sahiwal, and Sheikhupura districts.

9. Successful TA outcomes can be scaled up and scaled out through ADB investments. These outcomes may include basmati rice commercialization, public–private partnership rice value chain infrastructure development, or agribusiness projects that finance selected private sector companies demonstrating good performance under the TA in agriculture machinery development, advisory and extension services, and linking farmers to the market.

III. THE TECHNICAL ASSISTANCE

A. Impact and Outcome

10. The TA impact will be higher incomes of basmati rice farmers in Punjab. The outcome will be improved basmati rice productivity and quality in TA pilot sites.

B. Methodology and Key Activities

11. The TA outputs will be (i) improved basmati seed varieties, (ii) improved farming and postharvest practices, and (iii) improved research and service capabilities.

12. **Improved basmati seed varieties.** Since 2009, the PARB has supported varietal research to make Super Basmati, Basmati 515, and pipeline varieties resistant to BLB by funding and coordinating research efforts at the Rice Research Institute, Nuclear Institute for Agriculture and Biology, National Institute for Biotechnology and Genetic Engineering, Ayub Agricultural Research Institute, and Emkay Seeds Limited, a private R&D company. These institutions have made significant progress in developing promising new breeding lines resistant to BLB that could be released in 2–3 years; however, the release is constrained by shortage of funds for trial testing and lack of proper genes from the IRRI. Supplementing the ongoing work of the national research centers, the TA will (i) support the evaluation of high-yielding, BLB-resistant basmati varieties under field conditions and advance their release; (ii) introduce and transfer additional BLB-resistant genes from the IRRI into Pakistan basmati lines; and (iii) finance joint research in the IRRI and national institutions on adding drought-tolerant,

[8] Planning and Development Department, Government of Punjab. *2012 Medium Term Development Framework 2012–2015 and Development Programme 2012–2013*. Lahore.
[9] ADB. 2009. *Operational Plan for Sustainable Food Security in Asia and the Pacific.* Manila.
[10] ADB. 2006. *Report and Recommendation of the President to the Board of Directors: Proposed Multitranche Financing Facility for the Punjab Irrigated Agriculture Investment Program*. Manila.

submergence-tolerant traits, or both, into BLB-resistant lines. The TA will support specific research studies (e.g., grain discoloration) and finance field and laboratory equipment.

13. Requests for germplasm acquisition from the IRRI will be coursed through the Pakistan Agricultural Research Council (PARC), which will then interface with the IRRI in introducing the germplasm to Pakistan, in accordance with the standard material transfer protocol between Pakistan and the IRRI. Once the improved seed varieties are available from the research institutes, the PARC, as mandated, will facilitate national uniform yield trials.

14. **Improved farming and postharvest practices.** Through a competitive grant scheme, the TA will support public and private service providers to pilot test and demonstrate innovative practices and develop appropriate marketable technologies that will result in increased basmati productivity and reduced postharvest loss. Proposals will be solicited for initiatives in areas such as (i) refining a direct seeding method in farmer fields for better seed usage;[11] (ii) developing, testing, and demonstrating an appropriate seed drill to make direct seeding more efficient; (iii) mechanical transplanting with the introduction of appropriate transplanters to save labor and water and improve the plant population; (iv) expanding the introduction and operation of appropriate rice harvesters by the private sector; or (v) developing paddy drying technology and rice dryers to reduce moisture content and to avoid aflatoxin, which poses food safety hazards.

15. **Improved research and service capabilities**. Based on the needs assessment, the TA will develop and implement a capacity building and training plan for key stakeholders in the basmati value chain (i.e., public institutions, farmers, and private service providers) as well as a short training course on variety development in the IRRI. The TA will finance specific studies, such as a review of the public finance framework, to prepare proposals for adequate and sustainable agriculture R&D funding.

C. Cost and Financing

16. The TA is estimated to cost $1,200,000 equivalent, of which $1,000,000 will be financed on a grant basis by ADB's Technical Assistance Special Fund (TASF-V). The government will provide counterpart support in the form of counterpart staff, office accommodation, secretarial assistance, domestic transportation for counterpart staff, and other in-kind contributions. The cost estimates and financing plan are in Appendix 2.

D. Implementation Arrangements

17. The TA will be implemented over a period of 3 years (January 2014–December 2016). ADB will be responsible for overall TA management. The Agriculture, Rural Development and Food Security Unit of the Regional and Sustainable Development Department and the Environment, Natural Resources and Agriculture Division of the Central and West Asia Department will be ADB's focal point in collaboration with the Pakistan Resident Mission.

18. The PARB will be the executing agency and will establish a separate account to receive funds directly from ADB for eligible TA expenses. An advance payment facility will be provided to the PARB. The PARB chief executive will oversee TA implementation, and the TA will finance a national TA coordinator to work under the guidance and supervision of the PARB chief

[11] The PARC, Rice Research Institute, and Engro Eximp Ltd. have conducted direct seeding trials in farmer fields, and the results are promising. On machineries development and pilot testing, the TA will consult with the Agricultural and Biological Engineering Institute of the National Agricultural Research Center, Agricultural Machinery Institute, Punjab, and other similar institutes to ensure complementarities and value addition.

executive. The PARB will hold an inception workshop by March 2014 to provide a detailed work plan for each output, and a final workshop in December 2016 to communicate the TA results and lesson learned to researchers, farmers, and policy makers. The PARB will submit to ADB (i) an inception report by 31 March 2014, (ii) quarterly progress reports, (iii) a draft TA completion report by October 2016, and (iv) a final TA completion report by December 2016.

19. The TA proceeds will be disbursed in accordance with ADB's *Technical Assistance Disbursement Handbook* (2010, as amended from time to time). All procurement will be carried out in accordance with ADB's Procurement Guidelines (2013, as amended from time to time), and consultants will be recruited in line with ADB's Guidelines on the Use of Consultants (2013, as amended from time to time).

20. The TA requires 24 person-months of international consulting services on plant breeding, biotechnology, and agriculture engineering; and 36 person-months of national consulting services on TA coordination support. ADB will engage the IRRI in providing the international consulting services using single source selection. The choice of the IRRI is due to its long track record and internationally recognized research, training, and knowledge transfer works in developing new rice varieties and rice crop management techniques. The TA requires the provision of specific germplasm from the IRRI to Pakistan, and the IRRI, as a center of excellence on rice, is the only qualified institution with experience for the assignment. The value of the IRRI contract is about $437,000. ADB will engage the national TA coordinator on an individual basis. The outline terms of reference for consultants is in Appendix 3.

21. For output 2, service providers will be recruited through consultant qualification selection. Key selection criteria are (i) at least 5 years demonstrated relevant experience; (ii) clearly defined approach to (a) overcoming major constraints that result in low basmati yields, such as inappropriate farm practices, low input quality, poor cultural practices, and inadequate technical capacity of basmati farmers; (b) reducing production costs, adding value to basmati rice, or conserving resources; and (c) benefiting smallholder farmers; (iii) capacity to make counter-part contribution in cash or in kind (e.g., providing farms for research or providing contract farmers for the field testing and demonstration); (iv) qualification of experts with at least 5-year experience; (v) cost of proposal (the average grant amount per proposal will be $25,000, with a maximum of $40,000); and (vi) compliance with ADB's Safeguard Policy Statement (2009). The PARB will submit selected proposals to ADB for approval first before entering into agreements with the public or private service providers.

22. The TA will have a semi-annual review by ADB. The PARC will be responsible for conducting a baseline assessment at TA inception and an impact evaluation at TA completion. Parameters, including yield, landholdings, cropping pattern, input use, disease resistance, drought or submergence tolerance, and farmer and consumer preference, will be evaluated. Scientific and economic comparative analyses of the new initiatives will be done to make farmers and agribusiness beneficiaries more aware of their options. Good practices and lessons learned will be prepared, including a manual on good farming and postharvest practices with private sector engagement, to be disseminated through national workshops and publications.

IV. THE PRESIDENT'S DECISION

23. The President, acting under the authority delegated by the Board, has approved the provision of technical assistance not exceeding the equivalent of $1,000,000 on a grant basis to the Government of Pakistan for the Punjab Basmati Rice Value Chain, and hereby reports this action to the Board.

DESIGN AND MONITORING FRAMEWORK

Design Summary	Performance Targets and Indicators with Baselines	Data Sources and Reporting Mechanisms	Assumptions and Risks
Impact Higher incomes of basmati rice farmers in Punjab	Average net farmer revenue increases to PRs90,000/hectare by 2020 (baseline: PRs70,000/hectare in 2013)	Pakistan Bureau of Statistics agricultural data Pakistan Economic Survey	**Assumption** The political situation remains stable **Risk** Natural disasters, such as drought or flooding
Outcome Improved basmati rice productivity and quality in TA pilot sites	Average paddy rice yield in controlled TA pilot sites increased to 3 tons/hectare in 2016 (baseline: about 2.4 tons/hectare in 2013) Average paddy loss from BLB in percentage of production reduced to 5% in 2016 (baseline: 16% in 2013) Losses from harvest and postharvest methods reduced to 15% in 2016 (baseline: average of 25% in 2013)	Punjab Agricultural Statistics Punjab Agriculture Department report	**Assumptions** Commitment by research institutes to the TA is sustained Energy and fertilizer prices do not increase dramatically **Risk** Insect pest outbreaks
Outputs 1. Improved basmati seed varieties	At least three high-yielding, BLB-resistant lines ready for national uniform yield trial (by December 2014) At least three high-yielding BLB-resistant lines approved by the Punjab Seed Council (by December 2016) At least six advanced, high-yielding, BLB-resistant lines with additional IRRI genes developed (by December 2016) At least six advanced, high-yielding, BLB-resistant, and drought-tolerant lines developed (by December 2016) At least six advanced, high-yielding, BLB-resistant, and submergence-tolerant lines developed (by December 2016)	PARB report Punjab Seed Council approval Feedback surveys from trainees Punjab Agriculture Department Report	**Assumption** Private service providers actively participate, and public research agencies cooperate with private sector participants

Design Summary	Performance Targets and Indicators with Baselines	Data Sources and Reporting Mechanisms	Assumptions and Risks
2. Improved farming and postharvest practices	At least three competitive grant proposals approved by the PARB board each year (from January 2014 to December 2016) New technologies and machineries demonstrated to 1,000 farmers (by December 2016) 10,000 hectares covered as testing and demonstration areas for the new technologies and machineries (by December 2016)		
3. Improved research and service capabilities	8 rice scientists attended short training course on variety development in IRRI (by October 2016) 50 male and female farmers trained as trainers (by October 2016) Four workshops organized with participation of researchers, policy makers and farmers (by October 2016)		

Activities with Milestones

1.1 Contract negotiations with the IRRI concluded (by 31 December 2013)
1.2 National TA coordinator recruited (by 31 January 2014)
1.3 TA 3-year work plan and detailed 1st year work plan prepared by the PARB (by 31 March 2014)
1.4 TA-specific research works undertaken at the Nuclear Institute for Agriculture and Biology, National Institute for Biotechnology and Genetic Engineering, Rice Research Institute, and Emkay Seeds Ltd. (from 1 January 2014 to 31 December 2016)
1.5 Genes to be introduced from the IRRI identified (by 31 March 2014)
1.6 Identified IRRI genes provided to Pakistan (by 30 June 2014)
1.7 Advanced lines of BLB-resistant and drought- or submergence-tolerant Super Basmati and Basmati 515 varieties developed (by December 2016)
1.8 High-yielding BLB-resistant varieties approved by the Punjab Seed Council (by December 2016)
1.9 Research results on grain discoloration published (by June 2015)

Inputs

ADB: $1,000,000 (TASF-V)

Item	Amount ($)
Consultants	508,413
Equipment	50,000
Training and workshops	100,000
Surveys and studies	50,000
Competitive innovation grants	200,000
Miscellaneous administration and support costs	20,000
Contingencies	71,587

The government will provide counterpart support in the form of counterpart staff, office accommodation, secretarial assistance, domestic transportation for counterpart staff, and other in-kind contributions.

2.1 Competitive grant scheme advertised (by January 2014) 2.2 First two competitive grant proposals received, evaluated, and approved (by June 2014) 2.3 Direct seeding method refined and tested in farmer fields (by December 2015) 2.4 Seed drill developed, tested, and demonstrated (by December 2015) 2.5 Paddy drying technology replicated, tested, and demonstrated (by December 2015) 2.6 Other innovations tested and demonstrated in farmer fields (by September 2016) 2.7 Impacts of the new techniques evaluated (by December 2016) 3.1 Baseline survey completed (by 31 May 2014) 3.2 Capacity building and training plan developed by the PARB and approved by ADB (by March 2014) 3.3 Capacity building and training plan implemented (from April 2014 to October 2016) 3.4 Proposals for adequate and sustainable agriculture R&D funding submitted to the Punjab government (by December 2014) 3.5 TA impact evaluation completed (by December 2016) 3.6 Workshop and individual meetings to communicate results and lesson learned to researchers, policy makers, and farmers organized (by December 2016)	

ADB = Asian Development Bank, BLB = bacterial leaf blight, IRRI = International Rice Research Institute, PARB = Punjab Agricultural Research Board, R&D = research and development, TA = technical assistance.
Source: Asian Development Bank.

COST ESTIMATES AND FINANCING PLAN
($)

Item	Amount
Asian Development Bank[a]	
1. Consultants	
a. Remuneration and per diem	
i. International consultants	334,613
ii. National consultants	81,000
b. International and local travel	87,800
c. Reports, translation, and communications	5,000
2. Equipment[b]	50,000
3. Trainings and workshops	100,000
4. Surveys and studies	50,000
5. Competitive innovation grants	200,000
6. Miscellaneous administration and support costs[c]	20,000
7. Contingencies	71,587
Total	**1,000,000**

Note: The technical assistance (TA) is estimated to cost $1,200,000, of which contributions from the Asian Development Bank are presented in the table above. The government will provide counterpart support in the form of counterpart staff, office accommodation, secretarial assistance, domestic transportation for counterpart staff, and other in-kind contributions. The value of government contribution is estimated to account for 16.67% of the total TA cost.

[a] Financed by the ADB's Technical Assistance Special Fund (TASF-V).

[b] Including field and laboratory equipment, seed drills, transplanters, and dryers. After completion of the TA, equipment will remain with concerned research agencies.

[c] Including, for example, field and office supporting staff, stationery, internet services.

Source: Asian Development Bank estimates.

OUTLINE TERMS OF REFERENCE FOR CONSULTANTS

A. International Consultants

1. The technical assistance (TA) will engage 24 person-months of international consulting services from the International Rice Research Institute (IRRI) using single source selection. The IRRI will need to submit (i) an inception report within 2 weeks of fielding, covering assessment of current research status in Pakistan, approach and methodology, work plan, and implementation timeline for anticipated outputs; (ii) semi-annual progress reports on progress and results delivered; (iii) a draft final report by October 2016; and (iv) a final report acceptable to ADB by December 2016.

1. Plant Breeder and Team Leader (international, 9 person-months)

2. The plant breeder will work on the knowledge transfer and development of high-yielding, bacterial leaf blight (BLB)-resistant, and drought- or submergence-tolerant rice varieties. He or she will perform the following tasks:

(i) Supervise and coordinate overall IRRI services, including the inputs and deliverables of the other IRRI experts.
(ii) Assess the research status in partner national research institutes, and help the national research institutes in preparing cooperative and complementing 3-year work plans, including a detailed first year work plan.
(iii) Assist national scientists to identify resistant genes and suitable quantitative trait locus for drought tolerance and Sub1 genes for breeding activities.
(iv) Evaluate advanced breeding basmati lines with BLB resistance.
(v) Incorporate additional BLB-resistant genes into basmati background.
(vi) Incorporate suitable drought quantitative trait locus and Sub1 genes into basmati BLB-resistant lines.
(vii) Assist national scientists in conducting field testing of new advance lines with resistance to BLB and tolerance to drought or submergence.
(viii) Assist national scientists in establishing demonstration plots for field schools and capacity building programs for farmers, agriculture and extension workers, and seed company staff.
(ix) Assist national scientists in purification and multiplication of breeder seed.
(x) Assist in assessing the capacity development needs of the key stakeholders in the basmati value chain (i.e., government institutions, farmers, and the private service providers) and developing a capacity building plan.
(xi) Develop information and training materials on rice breeding and rice production of stress-tolerant varieties for a range of stakeholders (i.e., research institutions, nongovernment organizations, and rural communities).
(xii) Provide scientific support, guidance, and breeding materials to national partners in establishing breeding programs for developing the new varieties.
(xiii) Interact with national partners and with ADB for reporting and TA execution.

3. The plant breeder will have a PhD in a relevant field and be an expert with at least 10 years of experience in plant breeding, genetics, agronomy, seed multiplication, dissemination, and participatory varietal evaluation.

2. Biotechnologist (Plant Pathologist) (international, 6 person-months)

4. The biotechnologist (plant pathologist) will transfer knowledge and incorporate broad-based BLB-resistant rice varieties into basmati background. He or she will perform the following tasks:

(i) Work with national scientists to characterize and identify BLB-resistant gene(s) under rice-growing conditions in Pakistan, and transfer gene(s) into Super Basmati and Basmati 515.
(ii) Provide scientific support and guidance to national partners in new biotechnological techniques specially related to marker-assisted selection.
(iii) Contribute to developing information and training materials on pathological aspects for a range of stakeholders (i.e., research institutions, nongovernment organizations, and farming communities).
(iv) Contribute to developing a capacity building plan for key stakeholders in the basmati value chain.

5. The biotechnologist (plant pathologist) will have a PhD in a relevant field, with at least 10 years of experience on biotechnology application in plant breeding, genetics, seed multiplication, dissemination, and participatory varietal evaluation.

3. Biotechnologist (Drought and Submergence) (international, 6 person-months)

6. The biotechnologist (drought and submergence) will transfer knowledge and incorporate drought- and submergence-tolerant rice varieties with BLB-resistant ones using molecular techniques in basmati background. He or she will perform the following tasks:

(i) Work with national scientists to incorporate drought- or submergence-tolerant gene(s) under rice-growing conditions in Pakistan into basmati background varieties.
(ii) Provide scientific support and guidance to national partners in new biotechnological techniques specially related to marker-assisted selection.
(iii) Contribute to developing information and training materials on drought and submergence for a range of stakeholders (i.e., research institutions, nongovernment organizations, and farming communities).
(iv) Contribute to developing a capacity building plan for the key stakeholders in the basmati value chain.

7. The biotechnologist (drought and submergence) will have a PhD in a relevant field, with at least 10 years of experience on biotechnology application in plant breeding, genetics, seed multiplication, dissemination, and participatory varietal evaluation.

4. Agricultural Engineer (international, 3 person-months)

8. The agricultural engineer will perform the following tasks:

(i) Advise research institutes and private service providers on international good practices and technologies on agriculture equipment and machinery such as seed drills, transplanters, harvesters, and paddy dryers that are applicable to Pakistan basmati farming and harvesting; and advise on needed modifications to suit local conditions.
(ii) Advise and evaluate the TA's refining direct seeding method.

(iii) Advise and evaluate the TA's developing, testing, and demonstrating an appropriate seed drill.
(iv) Advise and evaluate the TA's testing and demonstration of mechanical transplanting with the introduction of appropriate transplanters.
(v) Advise and evaluate the private service providers' introduction and operation of appropriate rice harvesters.
(vi) Advise and evaluate the TA's replicating, testing, and demonstrating paddy drying technology and machinery.
(vii) Consult with and advise the Agricultural and Biological Engineering Institute of the National Agricultural Research Center and similar institutes on agriculture equipment that can be developed and pilot-tested to ensure complementarities and value addition.
(viii) Evaluate the impact of the new techniques tested and demonstrated under the TA.
(ix) Contribute to developing a capacity building plan for the key stakeholders in the basmati value chain.

9. The agricultural engineer should have at least a master's degree in a relevant field with at least 10 years of experience on agriculture machinery development, use, and dissemination.

B. National Consultant

10. The TA will separately engage 36 person-months of national consulting services on an individual basis.

1. TA Coordinator (national, 36 person-months)

11. The TA coordinator will work in the Pakistan Agricultural Research Board (PARB) under the guidance and supervision of the chief executive to perform the following tasks:

(i) Support the PARB in overall TA management and coordination with all related policy and research institutes, private service providers, and the IRRI to ensure efficient TA implementation.
(ii) Support the PARB in preparing and implementing the TA's 3-year implementation schedule and detailed annual work plan and cost estimates, and support the PARB on the TA progress reporting to ADB.
(iii) Monitor implementation of TA activities in relation to TA work plans, and in consultation with the PARB chief executive, take corrective action as required to ensure timely delivery of TA outputs.
(iv) Work with the PARB monitoring and evaluation unit to develop a TA monitoring system.
(v) Support the PARB in developing a capacity building plan for government institutions, farmers, and service providers, and coordinate and monitor its implementation.
(vi) Provide procurement advice and guidance to TA participants under the competitive grant scheme, assist in the preparation of procurement documents, and monitor the procurement process to ensure compliance with ADB guidelines and procedures.
(vii) Coordinate with private service providers on pilot testing innovative practices, and monitor their implementation.
(viii) Support the PARB in identifying and conducting specific TA-relevant surveys and

studies, and help the PARB prepare terms of reference.

(ix) Assist in the coordination and organization of workshops, training sessions, and meetings.

(x) Prepare progress reports, presentations, correspondence, and other TA documentation as required.

12. The TA coordinator should have at least a master's degree in agriculture-related sciences including social sciences or business administration. The TA coordinator should be proficient in English writing and communications, with at least 5 years of experience.