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Results of a global online expert survey:

Major constraints, opportunities and trends for banana production and marketing and priorities for future RTB banana research

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Abstract

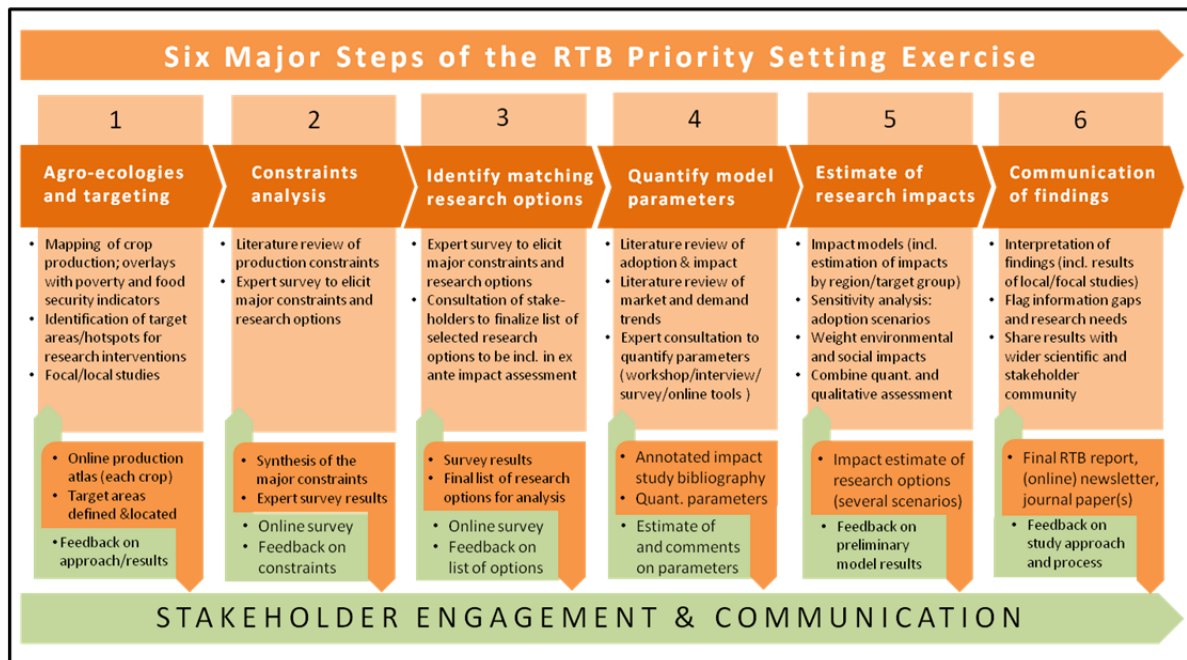
Acknowledgements

Results of a global online expert survey: Major constraints, opportunities and trends for banana production and marketing and priorities for future RTB banana research

1. Introduction and background

The global online banana expert survey is part of a multi-crop priority assessment exercise coordinated by the CGIAR Research Program on Roots, Tubers and Bananas (RTB) to identify the problems scientists should solve first and solutions most likely to have a positive impact on food security and livelihoods. For the banana priority assessment, Bioversity, the International Center for Tropical Agriculture (CIAT), and International Institute of Tropical Agriculture (IITA) have teamed up to carry out an impact study in consultation with banana stakeholders from around the world. The study follows a six-step participatory methodology (Fig. 1), with an emphasis on the needs of poor farmers and other vulnerable groups.

FIGURE 1. GRAPHICAL PRESENTATION OF THE RTB PRIORITY ASSESSMENT EXERCISE



2. Methodology and Data

2.1 METHODOLOGICAL APPROACH

The RTB priority assessment expert surveys were carried out for each of the five crops in 2012/13. Although the sampling strategy and some sections of the questionnaire vary, they all share the same general approach. This will allow all the results to be compiled, compared, and presented to the whole RTB in a coherent manner.

The basic tool for the expert surveys was a structured questionnaire based on a format applied by Fuglie (2007) for an earlier CIP priority assessment exercise. The questionnaire has been updated and adjusted to comply with the requirements of the current RTB priority assessment and specificities of each crop.

The questionnaire contains a section that asks for information about individual respondents. This information encompasses the type of organization a respondent works for; the country or region of expertise and the production system her work is focused on (for banana, the combination of cultivar group and crop association); demographic information such as the age, gender, years of experience in the field, and professional background. The main section of the questionnaire deals with the different constraints to crop production and marketing and related research options. Covering the different areas of RTB research, the research options are organized in a list around the areas of crop improvement, crop and resource management, seed management, genetic resources, value chains, postharvest utilization, and marketing, as well as socioeconomic and extension research. Respondents were asked to provide their perception of the level of importance of each listed research option for helping to reduce poverty and improve food security through research and capacity development using a scoring system from 1 = “not important” to 5 = “very important.”

The banana expert survey questionnaire included additional sections eliciting the major limiting factors for banana yield and key factors contributing to farmers’ income derived from growing banana as well as a question on the importance of particular general research fields. For each of these questions, respondents were asked to allocate a total of 120 points among the different factors/research fields listed (see Annex 2 for a copy of the questionnaire).

To facilitate the participation of especially national- and local-level experts, the banana questionnaire and all communication (newsletters, invitation emails, reminders, results posting) were provided in English, Spanish, and French. For the invitation letters, the language was preselected (English for experts from East and Southern Africa, Asia, and the Pacific; French for experts from West Africa; and Spanish for Latin America and the Caribbean [LAC]).

For the online survey, expert could choose their preferred language on the start page of the survey (see Fig. 2).

FIGURE 2. SCREENSHOT OF THE ONLINE SURVEY START PAGE (ENGLISH)



The online tool used for the survey was KeySurvey by WorldAPP (www.keysurvey.com). The survey tool allows for upload of contact lists, including a preselected language preference and automated email invitations and reminders that can be personalized (e.g., to include the contact's name). The tool also facilitates the allocation of a fixed number of points among a list of items (including an "others" option) and automatically computes the current total. Upon submission of the response the tool checks if the target number of points is met (indicating an error otherwise). All responses in any of the languages available are merged into one common database for the analysis and all French and Spanish responses to the open-ended constraints question were translated into English for the master database.

Results are analyzed by simple computation of mean scores for each of the research options evaluated in the survey, where higher values indicate the perception of higher importance among the respondents. To provide a rough indication of the significance of observed differences, the standard errors of the mean are calculated. The results are presented at the global level, using the entire sample as well as for regional and cultivar group subsamples.

2.2 SAMPLING PROCEDURE

The sampling strategy for the global banana expert survey made use of the existing global (ProMusa) and regional (BAPNET,¹ BARNESA,² Innovate Plantain,³ and MUSALAC⁴) banana networks to ensure a broad representation of relevant stakeholders and to further strengthen the networks as communication and knowledge exchange platforms. The regional network coordinators were contacted and provided with a template letter to reach out to the country representatives of their respective regional network.

The letter introduced the priority assessment study and the planned online expert survey and requested each country representative to compile a list of banana experts (names and contact information) from the representative's country. Lists were submitted by 48 countries (see Annex 3 for a list of countries and number of expert contacts submitted), and the combined country expert lists comprised 705 banana experts (including producers, extension staff, researchers, processors, nongovernmental organizations [NGOs], and government officials). In addition, 78 international banana experts from advanced research institutions (CGIAR Centers, universities, and research organizations in developed countries such as CIRAD) and all participants (247 listed participants but overlap with other two sources) of the last international banana conference held in 2008 in Mombasa were added to the sample. They were contacted with individual email invitations (see Annex 6 for the wording of the invitation email). The first batch of invitation emails to the survey was sent out on 18 January 2013, marking the official launch of the expert survey. As more expert contacts were submitted additional invitation emails were sent out. Invited experts received email reminders once a week after having received the initial invitation (all invitations and reminders featured a [REMOVE] tag which automatically removed contacts from the list).

On 28 January 2013, the open access link to the banana expert survey was made available through the RTB and ProMusa priority assessment webpages. On the same day, a group email announcing the launch of the survey was sent to all 2,200+ contacts in the ProMusa database and posts announced the survey on the RTB, ProMusa, and Regional Banana Network webpages. An open link to all the expert

¹ The Banana Asia-Pacific Network (BAPNET) was established in 1991, as ASPNET, to foster collaborative research on bananas, and renamed in 2001. BAPNET operates under the auspices of APAARI (Asia Pacific Association of Agricultural Research Institutes) and is guided by a steering committee, which is made up of heads of the national agricultural research institutes of member countries.

² The Banana Research Network for Eastern and Southern Africa (BARNESA) was established in 1994 to encourage cooperation between national research programs. The network was accepted and adopted by ASARECA (Association for Strengthening Agricultural Research in Eastern and Central Africa) as one of its constituent networks in 1995 and is now part of the ASARECA Staples Crop Programme.

³ Innovate Plantain is an innovation platform on plantain that replaces the regional R4D network for West and Central Africa known as MUSACO. The platform is managed by WECARD/CORAF (West and Central African Council for Agricultural Research & Development) and CARBAP, with technical backstopping from Bioversity International, IITA, CIRAD and FAO. The second meeting of the platform took place in November 2013 in Côte d'Ivoire.

⁴ MUSALAC is the Banana Research and Development Network for Latin America and the Caribbean. It was established in 1987 as the Latin America and the Caribbean Network (LACNET) and renamed in 2000. The network operates under the auspices of the Foro Regional de Investigación y Desarrollo Tecnológico Agropecuario para America Latina y el Caribe (FORAGRO) and is managed by a steering committee which meets every two years.

surveys, including the banana expert survey, was loaded onto the RTB webpage. In addition, the Instituto Interamericano de Cooperación para la Agricultura sent out an announcement of the RTB priority assessment expert study and included the link to the online surveys to all its 12,000+ list members.

All survey participants have been included in a database of global banana experts and are kept informed about the progress and preliminary results of the priority assessment study. We can invite these experts to further engage at different points of the priority assessment based on their indicated expertise.

3. Survey results

3.1 DEMOGRAPHICS AND OVERVIEW OF DATA

A total of 523 respondents from at least 54 different countries have participated in the global online banana expert survey. The majority of the sample (89%) is composed of experts from the compiled list (see description in the previous section) who had received a personal invitation email. The remaining 11% of the respondents used the open access link to enter the survey that had been posted on both the RTB and ProMusa webpage and announced through newsletters and other communication.

The online banana expert survey was available in three different languages; 58% of the respondents used the English version, 31% the Spanish version, and 11% the French language version.

The majority of respondents indicated a national (46%) or regional expertise (48%), whereas only a few respondents (7%) indicated a global expertise. The regional expertise (which equals in most cases the origin/base) of respondents was fairly equally distributed between sub-Saharan Africa (SSA) (35%), LAC (34%), and Asia/Pacific (24%). For the regional breakdown (Table 1), all respondents who indicated a national expertise were allocated to the respective geographical region where their country is located.

TABLE 1. GEOGRAPHICAL EXPERTISE (AND IN MOST CASES ORIGIN) OF SURVEY RESPONDENTS

	No. of Respondents	Share (% of total)	Female Respondents (% of total)
Global	34	6.5	26.5
LAC	176	33.7	19.7
SSA	184	35.1	22.8
Western and Central Africa	66	12.6	24.2
Eastern Africa	100	19.1	22.0
Southern Africa	18	3.4	22.2
Asia/Pacific	125	23.9	39.2
South Asia	28	5.4	21.4
Southeast Asia	79	15.1	46.8
The Pacific	18	3.4	33.3
Other	4	0.8	0
Total	523	100	25.8

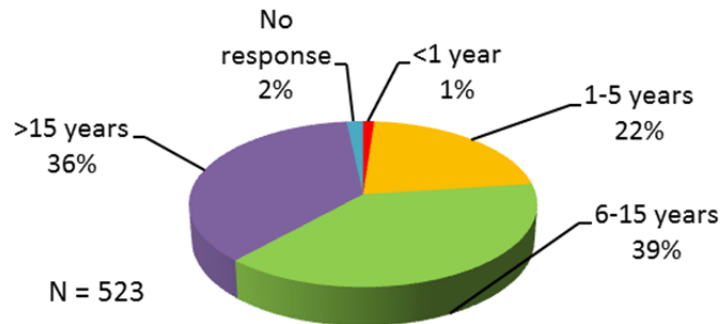
Note: Respondents indicating national expertise are allocated to the respective geographical region.

TABLE 2. NUMBER OF RESPONDENTS BY PROFESSION

	No of Respondents	Share (% of total)
Research leader/manager from national/regional research institute	58	11.09
Research scientist from a national agricultural research institute	174	33.27
Research scientist or lecturer at a university	106	20.27
Student (conducting research) at a university	12	2.29
Extension agent	13	2.49
Representative of an NGO	22	4.21
Representative of a donor to the CGIAR system	1	0.19
CGIAR center scientist	43	8.22
Employed by a private, for-profit company	21	4.02
Policy maker or civil servant	11	2.10
Other	59	11.28
No response (NA)	3	0.57
Total	523	100

Around 26% of the survey participants are women, with a large variation in the share of female respondents across regions (Table 1). While the share of women in the sample was lowest in LAC (20%), the largest share of women respondents with 47% was found in the subsample from Southeast Asia (this number is mainly driven by the large number of women from the Philippines who filled out the survey).

The majority of respondents were between 31 and 45 (34.6 % of respondents) and 46–65 years old (58.3%), which is in line with the sampling procedure to purposely select experts (i.e., persons who have acquired substantial expertise in this field during years of professional life). This is also reflected in the number of years of experience respondents have in the field. Most of the survey participants (39%) had 6–15 years of experience working in the area of banana research and development (R&D), and another 36% of the respondents even had more than 15 years of related experience (Fig. 3).

FIGURE 3. NUMBER YEARS OF EXPERIENCE IN BANANA R&D OF RESPONDENTS

Banana research is central to the institutions survey respondents work for: 28% indicated that banana is the highest priority crop, 55% stated that banana is among the priority crops, and only 11% said that banana research was not a priority for their organization.

When asked about recent changes in the importance of banana research in their respective organization, 49% of respondents indicated an increased importance. Only 14% reported a decrease and 32% stated that there has been no change in the importance of banana research at their organization over the past five years.

As part of the demographic information respondents were asked to indicate their profession (Table 2). The largest share of respondents are researchers at national agricultural research institutes (33%), followed by research scientists or lecturers at universities (20%), and research leaders or managers from national or regional research institutes (11%).

Some 8% of the sample consists of CGIAR scientists who will likely have been exposed to the latest RTB research strategy development and flagship formulation, which may have influenced their prioritization of constraints and research options.

To be able to detect and possibly later correct for disciplinary bias (i.e., breeders think that breeding is most important), respondents' disciplinary expertise was collected (Table 3). For this question respondents could indicate multiple areas of expertise and, on average, for the whole sample each person selected 4.8 different areas of expertise. Interestingly, men on average indicated more (5.1) fields of expertise than women (selected on average 3.9 areas).

TABLE 3. DISCIPLINARY EXPERTISE OF RESPONDENTS (TOTAL SAMPLE AND WOMEN AND MEN SEPARATELY)

	<i>Total No. of responses</i>	<i>Share (% of all respondents)</i>	<i>Women (% of females)</i>	<i>Men (% of males)</i>
Crop genetic resources	93	18.64	18.8	18.9
Plant breeding and conventional genetics	88	17.64	12.5	19.4
Participatory plant breeding	48	9.62	7.0	10.7
Transgenic research	67	13.43	16.4	12.6
Genomics, molecular biology	69	13.83	17.2	12.8
Bioinformatics	26	5.21	7.0	4.6
Tissue culture	108	21.64	21.9	21.6
Seed systems and virus management	63	12.63	11.7	13.1
Soils/nutrient management	107	21.44	9.4	25.7
Cropping/farming systems	154	30.86	12.5	37.7
Water management in crop production	43	8.62	3.1	10.7
Crop management, agronomy, and physiology	194	38.88	20.3	45.6
Crop diseases and disease management	214	42.89	39.1	44.3
Crop pests and pest management	147	29.46	22.7	32.2
Weed management	69	13.83	3.1	17.8
Economics or policy	48	9.62	6.3	10.7
Cultural anthropology or rural sociology	12	2.40	3.9	1.9
Monitoring and evaluation	82	16.43	18.0	16.1
Training and knowledge management	124	24.85	26.6	24.6
Technology dissemination/transfer	159	31.86	29.7	33.1
Value chain development and management	60	12.02	10.9	12.6
Postharvest crop utilization and marketing	82	16.43	17.2	16.4
Climate change	53	10.62	10.2	10.9
Nutrition	57	11.42	6.3	13.4
Research planning and administration	134	26.85	28.1	26.8
Development planning and administration	52	10.42	10.9	10.4
Other	57	11.42	13.3	10.9
Total	2,410	(100)	(100)	(100)

Note: Respondents could indicate more than one area of expertise. Men on average selected 5.11, and women on average 3.89 fields of expertise (4.83 areas of expertise on average for the whole sample). Red font highlights those fields with largest differences between male and female expertise.

Table 3 also shows the share of respondents indicating expertise in a given field for the whole sample and separately for male and female respondents. On the basis of our sample, some disciplines (e.g., soils/nutrient management, cropping/farming systems, crop pests, and pest and weed management) seem particularly “male dominated.”

Since there are important differences in the constraints and opportunities between the major banana cultivar groups, respondents were asked to indicate the production system (defined as the combination of cultivar group and cropping association) as well as the geographic region for which they are answering the constraints and research priority questions.

Respondents had the opportunity to fill the constraint and priority section of the questionnaire for more than one (up to three) different production system(s) or the same production system in different geographical regions. This resulted in a sample size for these questions which is larger (N = 674) than the number of respondents (N = 523) and the breakdown of observations by cultivar group and region is provided in Table 4. Since not all respondents filled all the questions or ranked all the research options, the number of observations varies.

TABLE 4. NUMBER OF OBSERVATIONS FOR CONSTRAINTS AND RESEARCH PRIORITIES BY CULTIVAR GROUP AND REGION

	Number of Observations for Constraints and Research Priority Questions by Region								ALL		
	WCA	EA	SA	LAC	SAs	SEA	P	Other	N	%	
Cavendish AAA	6	23	14	129	16	34	9	3	234	<i>34.7</i>	
Gros Michel AAA	2	1	0	16	1	7	0	0	27	<i>4.0</i>	
Other AAA dessert types	2	2	5	2	5	29	2	0	47	<i>6.9</i>	
East African Highland AAA	10	87	1	0	0	0	0	0	98	<i>14.6</i>	
Plantain AAB	69	4	0	80	8	7	2	0	170	<i>25.2</i>	
Other AAB, incl. South Pacific plantains	0	1	0	11	3	2	5	0	22	<i>3.3</i>	
ABB cooking bananas	7	5	3	6	4	28	6	0	59	<i>8.8</i>	
Diploid types	1	1	0	1	2	10	2	0	17	<i>2.5</i>	
ALL	N	97	124	23	245	39	117	26	3	674	100
	%	<i>14.4</i>	<i>18.4</i>	<i>3.4</i>	<i>36.4</i>	<i>5.8</i>	<i>17.4</i>	<i>3.9</i>	<i>0.4</i>	100	/

Note: WCA, West and Central Africa; EA, Eastern Africa; SA, Southern Africa; LAC, Latin America and the Caribbean; SAs, South Asia; SEA, Southeast Asia; P, Pacific.

3.2 MAJOR CONSTRAINTS (OPEN-ENDED QUESTION)

The questionnaire section eliciting major constraints and banana priority research options started with an open-ended question on the top three major constraints the respective cultivar faced in the selected region today. The answers to this question were all translated into English and then coded so that similar responses can be combined.

Figure 4 shows the shares of the constraints listed as top most important by the experts (pooled across all regions and cultivars). Pests and diseases in general feature very prominently, with Sigatoka

(16% of responses) as the most frequently mentioned specific disease, followed by Fusarium (7%), and bacterial wilt (4%). The picture changes when responses for all three major constraints are pooled (Fig. 5). The availability/access to (clean/high-yielding) planting material and soil fertility rank very prominently among the top three constraints listed.

FIGURE 4. RESPONSES TO THE OPEN-ENDED QUESTION ON TOP MAJOR CONSTRAINT (ALL CULTIVARS/REGIONS)

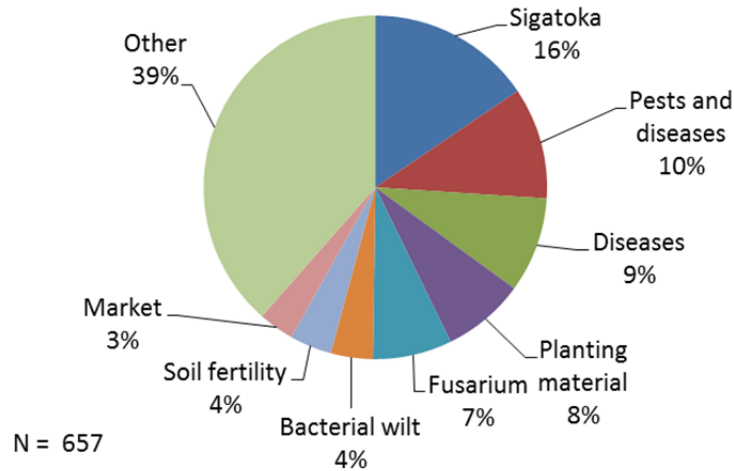
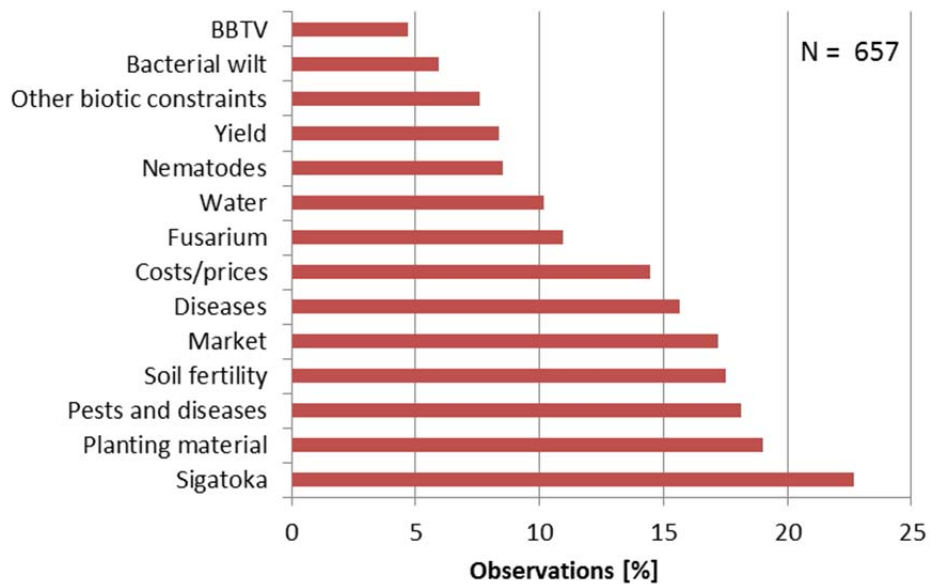


FIGURE 5. RESPONSES TO THE OPEN-ENDED QUESTION ON TOP THREE MAJOR CONSTRAINTS (ALL CULTIVARS/REGIONS)



Regionally limited or recently spreading disease problems such as banana bunchy top virus (BBTV) are only mentioned among the top three constraints in some 5% of the observations (Fig. 5). If, however, the importance of a constraint in a specific region or cultivar group is analyzed, the results become more refined. The importance of bacterial wilt in East African Highland (EAH) banana and for Western and Central Africa (WCA) and BBTV in Eastern Africa are noteworthy (Table 5).

TABLE 5. MAJOR CONSTRAINTS ELICITED WITH THE OPEN-ENDED QUESTION (BY REGION/CULTIVAR GROUP)

Region	Valid N	Top Constraint	(%)	Second Major Constraint	(%)
LAC	96	Planting material	16.7	Pests and diseases	9.4
WCA	123	Pests and diseases	22.0	Bacterial wilt	17.9
Eastern Africa	23	BBTV	21.7	Pests and diseases	17.4
Southern Africa	243	Sigatoka	37.4	Planting material	6.2
South Asia	39	Fusarium	15.4	Planting material	12.8
Southeast Asia	108	Fusarium	23.1	Diseases	21.3
The Pacific	25	Diseases	12.0	Pests and diseases	8.0
Cultivar group	Valid N	Top Constraint	(%)	Second Major Constraint	(%)
Cavendish AAA	234	Sigatoka	27.8	Pests and diseases	9.4
Gros Michel AAA	27	Fusarium	33.3	Diseases	14.8
Other AAA dessert types	47	Diseases	25.5	Pests and diseases	17.0
EAH AAA	98	Bacterial wilt	23.5	Pests and diseases	21.4
Plantain AAB	170	Sigatoka	18.8	Planting material	14.7
Other AAB, incl. South Pacific plantains	22	Fusarium	36.4	Sigatoka	9.1
ABB cooking bananas	59	Diseases	11.9	Pests and diseases	10.2
Diploid types	17	Diseases	23.5	Fusarium	11.8

The major problem with open-ended questions is that responses can be very general or very specific; across the sample they tend to be at very different levels of specificity. This substantially limits the information content of analysis based on this kind of information. The major purpose of including such an open-ended question in the questionnaire was (1) to give the respondents the chance to first “speak from their heart” (i.e., be able to voice the concern most pressing to them) and (2) to confirm that no major constraint has been left out in the lists used in the structured subsequent questions.

Yield-limiting factors

For the elicitation of major constraints to yield, respondents were asked to allocate a total of 120 points to a list of constraints (see question B3 in Annex 2 for the full list of factors). The five highest ranking, single constraints based on all responses (see Table 6 for details) are:

- Planting material infested with pests and/or diseases
- Black sigatoka
- Water deficits
- Fusarium wilt (FW)
- Planting material with non-uniform yield potential.

However, the scores vary across cultivar groups (Fig. 6) and regions (e.g., BBTV is the highest ranking yield constraint among respondents from South Africa, *Xanthomonas* wilt for EAH bananas and Eastern Africa). On average, the respondents allocated 32% of points to diseases, 19% to pests, 18% to climatic constraints and soil constraints each, 9% of points to planting material constraints, and 4% to other biotic constraints (Fig. 7).

TABLE 6. HIGHEST RANKED BANANA YIELD-LIMITING FACTORS ACCORDING TO GLOBAL MEAN SCORE

Yield-Limiting Factor	ALL regions (N = 661)		LAC (N=239)	SSA (N=242)	Asia/P (N=177)	CGIAR (N=52)	Male (N=495)	Female (N=171)
	Mean score	s.e. (mean)	Mean score	Mean score	Mean score	Mean score	Mean score	Mean score
Planting material infected with pests and/or diseases	11.36	0.41	9.59	13.28	11.23	17.32	11.00	12.61
Black leaf streak /black sigatoka	10.31	0.55	19.43	5.34	4.98	6.70	11.19	7.46
Water deficit	6.57	0.28	5.87	7.64	5.88	7.88	6.66	6.39
FW	5.95	0.41	5.04	3.93	9.87	9.34	5.81	6.49
Planting material with non-uniform yield potential	5.10	0.28	4.51	5.05	6.06	4.40	5.06	5.23
Banana weevil	4.68	0.24	5.60	5.40	2.45	4.04	4.92	4.07
Wind	4.64	0.27	4.35	3.43	6.51	2.84	4.53	5.05
Burrowing nematode	4.41	0.22	5.32	4.81	2.68	5.06	4.78	3.34
BBTV	4.29	0.31	0.41	5.55	7.88	8.50	3.60	6.45
<i>Xanthomonas</i> bacterial wilt	3.87	0.36	0.34	9.80	0.60	10.42	4.17	3.06

Note: Top-ranked yield constraints per category in red font, second tenth highest ranked constraints in green font.

FIGURE 6. MAJOR YIELD-LIMITING FACTORS BY CULTIVAR GROUP

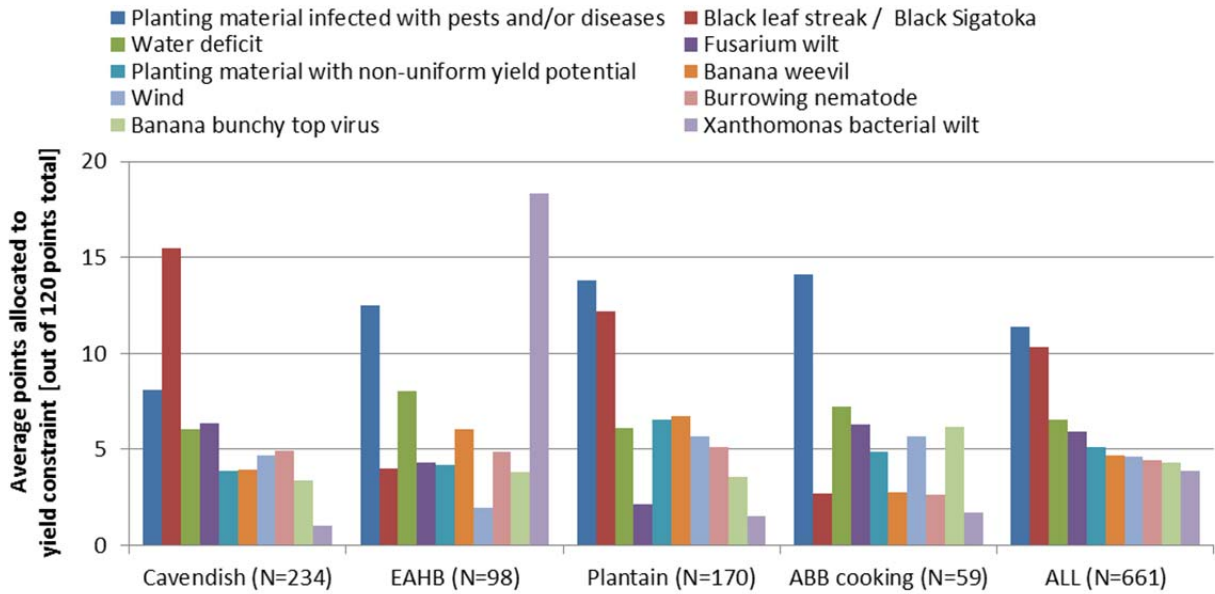
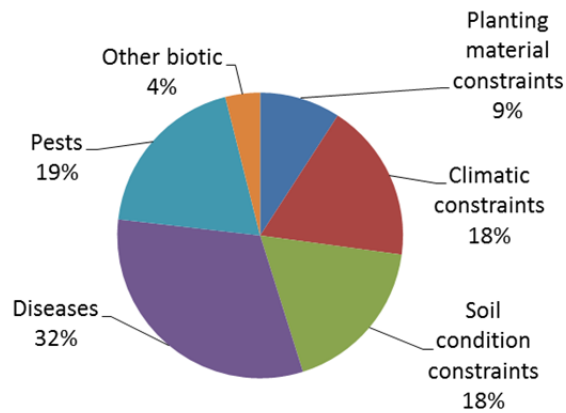


FIGURE 7. AVERAGE WEIGHT (% OF TOTAL POINTS ALLOCATED) ASSIGNED TO CATEGORIES OF YIELD-LIMITING FACTORS



3.3 INCOME DETERMINING FACTORS

The importance of different factors in increasing the income of banana farmers was again assessed by allocation of 120 points among factors from a list (see question B4 in Annex 2 for the full list). The five highest ranking, single income-increasing factors based on all responses are:

- Higher yield
- Better quality of bunch and/or fingers
- Improved information and knowledge of agronomic practices
- Improved information and knowledge on pest/disease management
- Lower cost of fertilizer and pesticides.

There is much less variation across regions and/or cultivar groups in the ranking of the income-determining factors (Table 7 and Fig. 8) compared to the yield-limiting factors. On average, respondents allocated 34% of points to production-related factors; 26% to factors related to postharvest, processing, and marketing, 21% to information and knowledge factors; 10% and 8% to socioeconomic and policy factors, respectively; and 1% to other factors (Fig. 9).

TABLE 7. HIGHEST RANKED BANANA INCOME-DETERMINING FACTORS ACCORDING TO GLOBAL MEAN SCORE.

Income-Determining Factor	ALL regions (N = 653)		LAC (N=238)	SSA (N=238)	Asia/P (N=174)	CGIAR (N=52)	Male (N=495)	Female (N=171)
	Mean score	s.e. (mean)	Mean score	Mean score	Mean score	Mean score	Mean score	Mean score
Higher yield	13.17	0.41	13.50	12.27	13.83	17.71	13.61	11.99
Better quality of bunch and/or fingers	8.89	0.31	9.46	7.49	9.97	7.94	8.75	9.48
Improved information and knowledge on agronomic practices	8.45	0.25	9.32	8.51	7.20	8.96	8.86	6.99
Improved information and knowledge on pest and disease management	7.72	0.27	8.72	6.90	7.49	10.47	7.85	7.39
Lower cost of fertilizer and pesticides	7.12	0.31	9.21	5.16	6.89	4.61	7.28	6.79
Reduced postharvest losses	6.47	0.23	5.46	6.77	7.56	5.71	6.24	7.08
Improved market access I: urban areas/local markets	4.88	0.23	3.18	6.43	5.16	7.35	4.78	5.12
Lower costs of other production inputs	3.89	0.20	3.75	3.62	4.42	3.63	4.14	3.27
Improved access to credit	3.89	0.20	4.35	3.89	3.34	3.31	3.80	4.10
Improved information and knowledge on prices	3.64	0.16	3.11	4.17	3.67	3.84	3.73	3.30

Note: Top ranked income factors per category in red font, second tenth highest ranked factors in green font.

FIGURE 8. MAJOR INCOME-DETERMINING FACTORS BY CULTIVAR GROUP

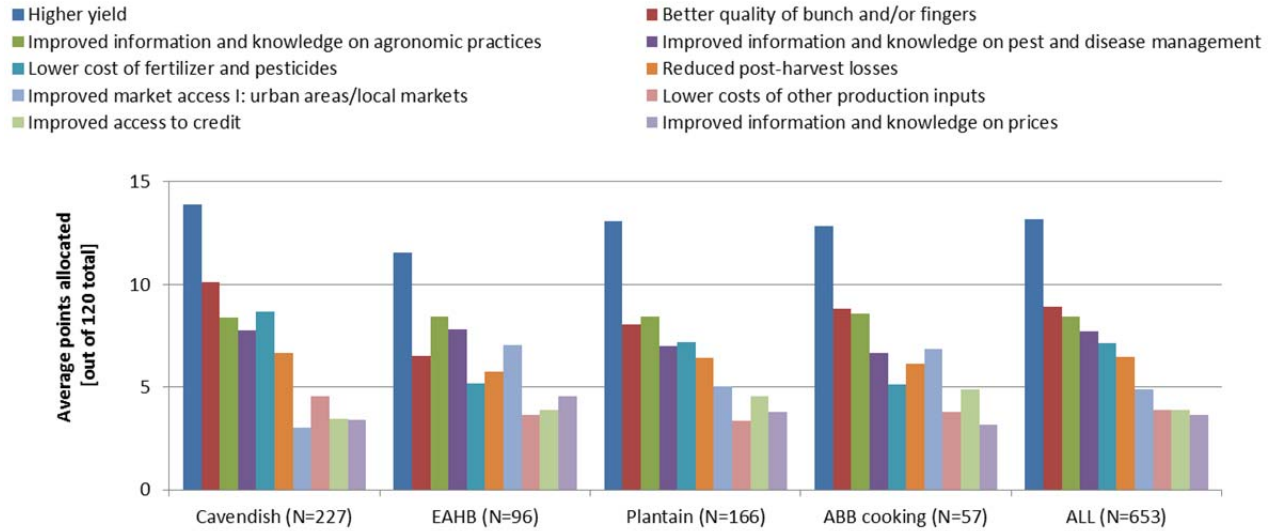
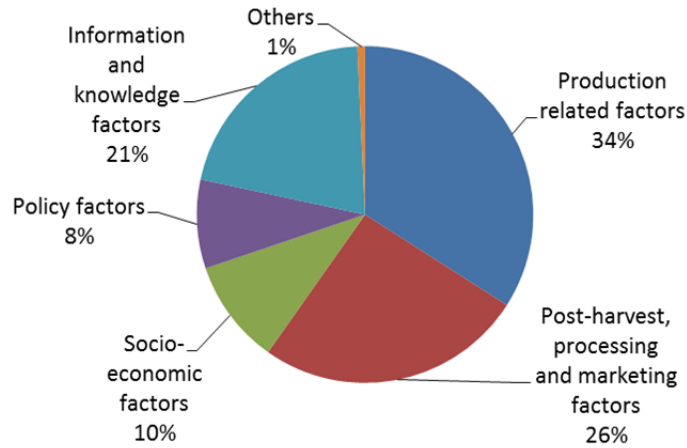


FIGURE 9. AVERAGE WEIGHT (% OF TOTAL POINTS) ASSIGNED TO INCOME-DETERMINING CATEGORIES



3.4 IMPORTANCE OF RESEARCH OPTIONS

The importance of 71 different research options (see question B5 in Annex 2) was evaluated by respondents on a scale from 1 (not important) to 5 (extremely important). Among all responses the following five technology options received an average score larger than 4 (very important): breeding for higher yields, research on the management of fungal leaf disease (excl. resistant varieties), breeding for resistance to fungal leaf diseases, strategies to improve soil fertility (micronutrients and fertilizer), and methods for improved phytosanitary and physiological quality of planting material.

Again the average scores and ranking of research options vary substantially between regions (Table 8) and cultivar groups (Table 9). For example, respondents from Asia and the Pacific gave highest importance to the breeding for resistance to Fusarium, which globally is only ranked 12. Interestingly, CGIAR respondents put greatest emphasis on the management of FW, excluding resistant varieties. Some of highest ranked research options on a regional level did not make it into the global top 10. For example, breeding for virus resistance (e.g., BBTV, BSV) was among the top 10 research options in SSA and Asia/Pacific (as well as for CGIAR respondents). Similarly, respondents from Africa and Asia/Pacific, as well as female respondents, ranked research to improve the shelf life of bananas among the top 10 options. For the full results (average scores of each research options by region, sub-region, gender, and cultivar group), consult the tables in Annexes 4 and 5.

TABLE 8. HIGHEST RANKED BANANA RESEARCH OPTIONS BASED ON GLOBAL MEAN SCORE (REGIONAL BREAKDOWN)

Global Rank	Research Options	ALL	LAC	SSA	Asia/P	CGIAR	Male	Female
		Mean score	Mean score	Mean score	Mean score	Mean score	Mean score	Mean score
1	Breeding for high yield	4.21	4.14	4.40	4.05	4.17	4.25	4.07
2	Management of fungal leaf disease (excl. resistant varieties)	4.11	4.40	3.88	3.85	3.77	4.16	3.91
3	Breeding for resistance to fungal leaf diseases	4.11	4.45	3.82	3.85	3.71	4.15	3.95
4	Strategies to improve soil fertility (micronutrients and fertilizer)	4.08	4.18	4.18	3.82	4.03	4.12	3.89
5	Methods for improved phytosanitary and physiological quality of planting material	4.01	4.04	4.07	3.92	3.94	4.04	3.88
6	Research on banana technology adoption	3.98	3.99	4.04	3.91	3.66	3.96	4.01
7	Improved methods for production and distribution of elite planting materials (formal seed system)	3.96	3.96	4.16	3.80	4.13	4.01	3.76
8	Management of FW (excl. resistant varieties)	3.96	4.09	3.71	3.99	4.21	3.94	4.02
9	Research on small farmer access to new technologies	3.92	3.93	3.97	3.87	3.73	3.90	3.95
10	Develop new extension strategies	3.91	4.00	4.04	3.67	3.97	3.92	3.90
10	Develop new training materials for extension	3.91	4.03	3.92	3.73	3.93	3.92	3.86
12	Breeding for resistance to Fusarium	3.89	3.95	3.63	4.06	3.85	3.89	3.89

Note: Top ranked research option in each category in red font, second tenth highest ranked options in green font.

In summary, respondents did not rank the research options for genetic resources management very highly (global ranks between 27 and 66). Only the phenotyping of land races was assessed by female respondents among the top 10 research options. The highest (global) ranked crop improvement options are breeding for high yield (1) and breeding for resistance to fungal leaf diseases (3). Some of the other resistance breeding options have a much higher regional importance than is reflected in the global score (e.g., breeding for virus resistance ranked highly in WCA, Eastern Africa, South and Southeast Asia; breeding for Fusarium resistance top ranked for Southeast Asia).

TABLE 9. HIGHEST RANKED BANANA RESEARCH OPTIONS BASED ON GLOBAL MEAN SCORE (BY CULTIVAR GROUP)

Global Rank	Research Options	ALL	Cavendish AAA	EAHB AAA	Plantain AAB	ABB Cooking Bananas
		Mean score	Mean score	Mean score	Mean score	Mean score
1	Breeding for high yield	4.21	4.04	4.45	4.34	4.16
2	Management of fungal leaf disease (excl. resistant varieties)	4.11	4.24	4.08	4.15	3.72
3	Breeding for resistance to fungal leaf diseases	4.11	4.32	3.98	4.20	3.47
4	Strategies to improve soil fertility (micronutrients and fertilizer)	4.08	4.04	4.29	4.19	3.76
5	Methods for improved phytosanitary and physiological quality of planting material	4.01	3.86	4.13	4.14	3.97
6	Research on banana technology adoption	3.98	3.91	4.00	4.09	4.06
7	Improved methods for production and distribution of elite planting materials (formal seed system)	3.96	3.82	4.15	4.18	3.77
8	Management of FW (excl. resistant varieties)	3.96	4.00	3.79	3.78	3.82
9	Research on small farmer access to new technologies	3.92	3.83	4.00	4.01	3.91
10	Develop new extension strategies	3.91	3.79	4.13	4.07	3.76
10	Develop new training materials for extension	3.91	3.81	3.82	4.13	3.85
12	Breeding for resistance to Fusarium	3.89	3.99	3.70	3.54	3.97

Note: Top ranked research option in each category in red font, second tenth highest ranked options in green font.

While strategies to improve soil fertility rank highly almost throughout (global rank 4), some other crop management research options such as improved water management have high scores only in some regions (Eastern Africa, South Asia, and for EAHB). The top ranked option for the Pacific is “strategies to manage microbes for soil, root and plant health” (global rank 13).

Two of the three planting material research options feature in the global top 10 list, while the third, informal seed system, globally ranks only 18. They are still considered of high importance especially in WCA, Eastern Africa, and the Pacific, as well as for EAHB and plantains.

Among the disease management research options, the result that merits special mention is the high score for “management of bacterial diseases” in Eastern Africa and especially for EAHB (top ranked research option for this cultivar group), which globally ranks only as 25. Similarly, for the pest control and management options, the management of nematodes is of high regional importance in Southern Africa yet is only ranked in the mid-field globally.

Although globally the research options on value chain, postharvest utilization, and marketing did not make it into the top 10 ranked list (15 is highest global rank given for “improving shelf life”), research in this field was ranked higher by female respondents (three out of the top 10 in this category) and especially for ABB cooking bananas (five out of the top 10 research options from this category).

Four of the research options from the categories socioeconomic, policy, and extension research are listed in the top 10. It is worth noting that research on banana technology adoption scored as the top one option in Southern Africa and the development of new training material is the highest ranked option in South Asia.

Finally, respondents prioritized general areas of banana research (not related to a particular production system) by allocating a total of 120 points among 13 distinct banana research areas (with an additional “other” option respondents could specify). The top five research areas based on the scoring of the whole sample are (1) research on disease and pest management (excl. resistant varieties) (12%); (2) breeding for higher yield (10%); (3) breeding for biotic stress resistance (9%); (4) crop management and production system research (9%); and (5) genetic resource management research (8%). Table 10 shows the results of the scoring exercise based on the indicated regional expertise of the experts.

The women in the sample assigned significantly fewer points to the area of breeding for higher yield (10% of points compared to 13% of points assigned by male respondents). They instead gave more points to research on postharvest handling and processing technology as well as value chain and marketing research and socioeconomic research (Table 11). Respondents working for the CGIAR assigned a higher priority to breeding for abiotic resistance compared to the other respondents.

TABLE 10. PRIORITIZATION OF BANANA RESEARCH AREAS BY GEOGRAPHIC EXPERTISE

Banana Research Area	Geographical Area of Expertise								
	ALL (N = 498)	Global (N=34)	WCA (N=62)	EA (N=94)	SA (N=16)	LAC (N=169)	SAs (N=25)	SEA (N=76)	P (N=18)
	Mean score	Mean score	Mean score	Mean score	Mean score	Mean score	Mean score	Mean score	Mean score
Research on disease and pest management (excl. resistant varieties)	13.84	16.47	10.65	11.94	12.25	14.83	11.76	15.97	16.39
Breeding for higher yield	12.15	9.68	12.03	12.09	13.56	13.40	9.88	11.67	9.06
Breeding for biotic stress resistance	11.24	21.24	9.26	10.14	11.50	10.89	10.80	9.87	13.17
Crop management and production system research	11.04	9.82	11.52	10.90	9.00	11.18	11.80	10.92	13.06
Genetic resource management research	9.69	12.76	10.18	7.79	10.44	9.72	9.40	9.62	11.78
Breeding for improved quality	9.53	8.91	8.79	8.20	9.38	10.18	8.00	10.91	9.72
Breeding for abiotic stress resistance	8.98	9.71	7.66	8.54	7.94	9.34	9.96	9.13	8.33
Planting material and seed system research	8.98	10.53	11.05	9.81	9.94	8.01	9.08	7.80	8.28
Research on postharvest handling and processing technology	8.80	3.97	9.87	10.35	7.94	8.08	9.36	10.30	6.06
Value chain and marketing research	8.04	5.00	9.06	9.43	9.19	7.40	8.72	8.14	7.28
Research on extension strategies, tools and materials	6.32	3.74	6.40	7.70	6.19	6.14	7.36	5.57	7.61
Socioeconomic research	5.08	3.35	7.06	5.94	5.56	4.45	5.56	5.04	3.22
Policy-oriented research	3.92	2.65	4.73	5.16	4.44	3.11	5.00	3.93	3.00
Others	2.39	2.18	1.74	2.02	2.69	3.28	3.32	1.12	3.06

Note: Top ranked research areas per category in red font, next four highest ranked in green font.

TABLE 11. PRIORITIZATION OF BANANA RESEARCH AREAS BY JOB TYPE AND GENDER

Banana Research Area	Job Type					Gender	
	ALL (N = 498)	Research Leader NARS (N=57)	Research Scientist NARS (N=167)	Research Scientist University (N=103)	CGIAR (N=42)	Male (N=367)	Female (N=130)
	Mean score	Mean score	Mean score	Mean score	Mean score	Mean score	Mean score
Research on disease and pest management (excl. resistant varieties)	13.84	13.14	13.97	14.44	14.26	13.61	14.45
Breeding for higher yield	12.15	12.32	12.53	12.00	9.88	12.94	9.85
Breeding for biotic stress resistance	11.24	11.75	11.84	11.87	12.33	11.41	10.68
Crop management and production system research	11.04	9.19	10.96	10.06	13.76	11.29	10.42
Genetic resource management research	9.69	9.77	9.93	11.42	8.38	9.77	9.54
Breeding for improved quality	9.53	9.44	10.03	9.12	6.90	9.68	9.03
Breeding for abiotic stress resistance	8.98	9.14	9.32	8.23	11.55	8.90	9.11
Planting material and seed system research	8.98	9.72	8.64	9.44	9.83	8.94	9.02
Research on postharvest handling and processing technology	8.80	9.42	8.50	8.46	7.00	8.44	9.88
Value chain and marketing research	8.04	7.98	6.89	8.61	9.19	7.79	8.80
Research on extension strategies, tools and materials	6.32	5.93	6.49	5.22	5.86	6.17	6.79
Socioeconomic research	5.08	5.00	4.65	5.63	4.93	4.80	5.91
Policy-oriented research	3.92	3.86	3.96	3.73	4.02	3.83	4.19
Others	2.39	3.33	2.28	1.78	2.10	2.41	2.35

Note: Top ranked research areas per category in red font, next four highest ranked in green font.

4. Discussion

The survey was a huge success in term of the number, geographical spread, and diversity of respondents. The effort to mobilize the country representatives of the regional networks and then reach out to affiliated experts with personalized emails and reminders worked especially well, and resulted in a much higher (some 50%) than normal response rate for online surveys. However, fewer countries from Asia returned country lists compared to Africa and LAC, which explains the relative under-representation of banana experts especially from South Asia in the sample.

In retrospect, the list of 71 banana research options was a little ad hoc, and the methodology to derive such a list merits some more careful thinking. However, since the open-ended question did not return any surprises, and the more systematic questions on yield-limiting and income-determining factors are very much in line with the scoring results, this does not seem to have compromised the survey results.

As always, there is scope for some more (sophisticated) analysis, such as testing for differences between groups, analysis of the effects of gender in a more systematic way, and systematic controlling for the effect of disciplinary background.

The results of the survey have been communicated back to the respondents via personalized email and were presented at bi-annual meetings of three of the regional networks (Annex 1). They were also provided as input for the selection of research options to be included in the RTB banana research assessment exercise.

Many of the respondents made use of the “comments” field at the end of the questionnaire to express their appreciation of the study and the survey and their thanks for being included in the list of invited participants. There was also a high level of interest of being informed of survey results, reflecting the fact that 98.6% of the respondents provided an email address so they can be contacted again.

5. References

Fuglie, Keith. 2007. Priorities for Sweetpotato Research in Developing Countries: Results of a Survey. *HortScience* 42 (5): 1200–1206.

Annexes

ANNEX 1. TIMELINE OF EXPERT SURVEY**2012**

- March** First meeting of RTB priority assessment taskforce and plan to conduct expert surveys
- June** Questionnaire developed by priority assessment taskforce and draft cassava questionnaire pre-tested during international cassava conference in Kampala
- Aug.** Questionnaire adapted for banana survey and reviewed by team of banana experts
- Oct.** Global banana expert survey set-up in online tool
- Nov.** Regional network coordinators contacted to request contact lists of banana experts
- Dec.** Submission of expert lists from regional network member country representatives; uploading contact/language information to online tool

2013

- Jan.** First batch of invitation emails sent out for survey
- Feb.** ProMusa newsletter announcing webpage and online survey (open link); more invitation emails to additional contacts; reminder emails to all invited contacts
- Mar.** Survey closes formally
- Apr.** Analysis of survey data and writing of draft report. Survey results sent to all survey participants and posted on ProMusa priority assessment webpage; survey results used in Kampala expert WS to inform selection of research option for the RTB banana priority setting exercise
- May** Survey results presented during bi-annual MUSALAC meeting
- Oct.** Survey results presented during bi-annual BARNESA meeting
- Nov.** Survey results presented during bi-annual “Innovate Plantain” meeting
- Dec.** Final report of global banana expert survey submitted to RTB

ANNEX 2. QUESTIONNAIRE FOR GLOBAL ONLINE BANANA EXPERT SURVEY

**Survey on major constraints to banana production
and priorities for banana research—2013**

Section A. Please tell us about the banana work done by yourself and your organization

A1. Are you ...? (please select one)

- a research leader/manager from a national/regional agricultural research institute
- a research scientist from a national agricultural research institute
- a research scientist or lecturer at a university
- a student (conducting research) at a university
- an extension agent
- a representative of a non-government, not-for-profit organization (NGO)
- a representative of a donor to the CGIAR system
- a CGIAR center scientist
- employed by a private, for-profit company
- a policy maker or civil servant
- other (please specify) _____

A2. What is the geographical focus of your banana work (please select one)?

- Global
- Regional – Western and Central Africa
- Regional – Eastern Africa
- Regional – Southern Africa
- Regional – Latin America and the Caribbean
- Regional – South Asia
- Regional – Southeast Asia
- Regional – Pacific
- National (please specify country) _____

(if selection “global”) **You have indicated a global focus of your banana work. Please select one geographic region for which you know banana production systems particularly well. Please answer the subsequent questions in this survey with that region in mind. (please select one)**

- Western and Central Africa
- Eastern Africa

- Southern Africa
- Latin America and the Caribbean
- South Asia
- Southeast Asia
- The Pacific

A3. Please indicate the banana production system - defined as a combination of cultivar and crop association - that your work is mainly focusing on.

First, please select the cultivar

- Cavendish AAA
- Gros Michel AAA
- Other AAA dessert types
- East African Highland AAA
- Plantain AAB
- Other AAB, incl. South Pacific plantains
- ABB cooking bananas
- Diploid types

Now, please indicate the most typical crop association for '[cultivar]' in the production system and region your work focuses on

- intercropped with perennial crops (coffee, coconut, cocoa)
- (2-5 years) intercropped with annual food crops
- (2-5 years) intercropped with short term annual crop during banana establishment
- (perennial) intercropped with annual food crops
- perennial monocrop
- frequently replanted monocrop

A4. Which organization do you work for? _____

A5. Is banana research an important priority for your organization? (please select one)

- Yes, banana is the highest priority crop for research in my organization
- Yes, banana is among the priority crops for research in my organization
- No, we do some research on banana, but it is not a priority crop
- No, we rarely or never conduct banana research

- No, we don't conduct research on banana but on other root and tuber crops
- No, we don't do any research
- I don't know

A6. How has the banana research and development done by your organization changed over the past five years?

- Decreased
- Stayed about the same
- Increased
- I don't know

Section B. Please assess major constraints, trends and priorities for helping to reduce poverty and improve food security through research and capacity development for '[repeat cultivar and crop association selected in A3]' in the region you have specified.

B1. In your opinion, what are the three top constraints to '[repeat cultivar and crop association]' in your region today?

(please be specific and rank according to importance with 1. = highest rank)

1. _____
2. _____
3. _____

B2. In your opinion, what will be the one most important change or development for '[repeat cultivar and crop association]' in your region over the next 10 years?

B3. What are the major constraints to yield (tons/ha/year) for '[repeat cultivar and crop association]' in your region? Please allocate a total of 120 points to the constraints listed in the table below.

Please read the entire list before starting to allocate points. Then please allocate a total of 120 points, give 0 points to factors you feel are of no or negligible importance (or just leave the fields blank). Please ensure that the most important factor has the highest number of points and factors of similar importance have the same amount of points.

	<i>Importance (allocated points)</i>
Planting material constraints	
Planting material infected with pests and/or diseases	
Planting material with non-uniform yield potential	
Other planting material constraints	
Abiotic constraints - Climate	
Water deficits	
Flooding	
Cold	
Heat	
Low radiation	
Wind	
Others climatic constraints	
Abiotic constraints - Soil conditions	
Acid soil	
Salinity	
Abiotic constraints - Soil conditions (continued)	
Poor drainage	
Shallow soil depth and barriers to roots	
Nutrient deficiencies – N	
Nutrient deficiencies - P	
Nutrient deficiencies - K	
Nutrient deficiencies – others	
Others soil condition constraints	
Biotic constraints - Diseases	
Banana bunchy top virus (BBTV)	
Banana streak virus (BSV)	
Banana bract mosaic virus	
Cucumber mosaic virus	
<i>Xanthomonas</i> bacterial wilt	
Moko disease (<i>Ralstonia</i>)	
Blood disease (<i>Ralstonia</i>)	
Fusarium wilt	
Black leaf streak / Black Sigatoka (<i>Mycosphaerella fijiensis</i>)	
Other <i>Mycosphaerella</i> leaf spot	
Cigar end rot	
Erwinia	
Others banana diseases	

	<i>Importance (allocated points)</i>
Biotic constraints - Pests	
Burrowing nematode (<i>Radopholus similis</i>)	
Banana lesion nematode (<i>Pratylenchus goodeyi</i>)	
Banana root nematode (<i>Pratylenchus coffea</i>)	
Banana root knot nematode (<i>Meloidogyne</i> spp.)	
Spiral nematode (<i>Helicotylenchus multicinctus</i>)	
Banana stem weevil (<i>Odoiporus longicollis</i>)	
Banana weevil (<i>Cosmopolites sordidus</i>)	
Banana mealybug	
Banana aphids	
Banana bunch pests	
Others banana pests	
Biotic constraints - Others	
Weeds	
Wild life (e.g. birds)	
Other biotic constraints	
TOTAL	(=120 Points)

B4. Please assess the importance of different factors in increasing the income that “the average” farmer receives from growing and marketing ‘[repeat cultivar / crop association here]’ in your region.

Please read the entire list before starting to allocate points. Then please allocate a total of 120 points, give 0 points to factors you feel are of no or negligible importance (or just leave the fields blank).

Please ensure that the most important factor has the highest number of points and factors of similar importance have the same amount of points.

	Importance (allocated points)
Production related factors	
Higher yield	
Better quality of bunch and/or fingers	
Lower cost of fertilizer and pesticides	
Lower cost of irrigation	
Lower cost of other production inputs	
Change in harvest time (seasonal fluctuation of produce price)	
Other production related factors	
Factors related to postharvest, processing and marketing of produce	
Reduced postharvest losses	
On-farm processing for value addition	
Membership in a cooperative or producer organization	
Certification (e.g. fair trade, organic)	
Improved market access I - urban areas/local markets	
Improved market access II - processing facilities	
Improved market access III - regional/export markets	
Higher demand for produce (reduced unsold surplus)	
Other factors related to postharvest, processing & marketing of produce	
Socioeconomic factors	
Secure land use rights	
(Improved) access to (reasonably priced) credit	
Reduction of theft	
Improved overall security	
Reduced discrimination due to farmer’s gender, ethnicity, religion or age	
Other socioeconomic factors	
Policy factors	
New/improved policies and/or regulations	

	Importance (allocated points)
Better enforcement of existing policies and/or regulations	
New/improved government programs and/or subsidies	
Other policy factors	
Information and knowledge factors	
Improved information and knowledge on agronomic practices	
Improved information and knowledge on prices	
Improved information and knowledge on natural resource management	
Improved information and knowledge on pest and disease management	
Other improved information and knowledge	
Other factors	
TOTAL	(=120 Points)

B5. Please assess the importance of the following research options for '[repeat cultivar and crop association here]' in your region in order to reduce poverty and improve food security.

	Importance 1=not important, 2=somewhat important, 3=important, 4=very important, 5=extremely important
A) Genetic resource management	
Research on in situ genetic resource management	1 2 3 4 5 don't know
Research on collection, characterization (incl. DNA fingerprinting), evaluation, documentation (ex situ)	1 2 3 4 5 don't know
Phenotyping of land races in search of high-value traits/new source of tolerance/resistance to stress	1 2 3 4 5 don't know
Molecular screening of land races in search of high-value traits/new source of tolerance/resistance to stress	1 2 3 4 5 don't know
Research on management of intellectual property rights and material transfer agreements	1 2 3 4 5 don't know
Research on better information about genetic resources and improved access to genetic resources	1 2 3 4 5 don't know
B) Crop improvement – Breeding for	
Higher yield	1 2 3 4 5 don't know
Improved processing quality	1 2 3 4 5 don't know
Shorter crop cycle	1 2 3 4 5 don't know

	Importance 1=not important, 2=somewhat important, 3=important, 4=very important, 5=extremely important
Higher Pro-Vitamin A (beta-carotene) content	1 2 3 4 5 don't know
Better retention of micronutrients during processing & storage	1 2 3 4 5 don't know
Delayed ripening / longer shelf life	1 2 3 4 5 don't know
Resistance to virus disease (BBTV, BSV)	1 2 3 4 5 don't know
Resistance to fungal leaf diseases	1 2 3 4 5 don't know
Resistance to bacterial diseases	1 2 3 4 5 don't know
Resistance to nematodes	1 2 3 4 5 don't know
Resistance to weevils	1 2 3 4 5 don't know
Resistance to Fusarium	1 2 3 4 5 don't know
Drought tolerance / water use efficiency	1 2 3 4 5 don't know
Cold tolerance / highland hardiness	1 2 3 4 5 don't know
Heat tolerance	1 2 3 4 5 don't know
Tolerance to waterlogging	1 2 3 4 5 don't know
Tolerance to marginal/saline soils	1 2 3 4 5 don't know
Improved nutrient use efficiency	1 2 3 4 5 don't know
Other crop improvement research	
Germplasm enhancement and pre-breeding	1 2 3 4 5 don't know
Exploitation of heterosis	1 2 3 4 5 don't know
Flowering ability/botanic seed production	1 2 3 4 5 don't know
Improved accelerated breeding methods	1 2 3 4 5 don't know
Exploitation of molecular markers	1 2 3 4 5 don't know
C) Production technology, agronomy, crop management research	
Strategies to improve soil fertility (micro-nutrients & fertilizer)	1 2 3 4 5 don't know
Strategies to manage soil acidity	1 2 3 4 5 don't know
Strategies to manage soil salinity	1 2 3 4 5 don't know
Strategies to manage microbes/microbial communities for soil, root & plant health	1 2 3 4 5 don't know
Strategies to improve water management in crop production	1 2 3 4 5 don't know
Improving banana mono-cropping systems	1 2 3 4 5 don't know
Optimizing banana production in mixed systems with annual food crops or perennial crops	1 2 3 4 5 don't know
Strategies to improve weed management and control	1 2 3 4 5 don't know
D) Planting material research	
Methods for improved phytosanitary and physiological quality of planting material	1 2 3 4 5 don't know

	Importance 1=not important, 2=somewhat important, 3=important, 4=very important, 5=extremely important
Improved methods for production and distribution of elite planting materials (formal seed systems)	1 2 3 4 5 don't know
Improved methods for farmer based production and distribution of planting materials (informal seed systems)	1 2 3 4 5 don't know
E) Research on disease management (excl. resistant varieties)	
Virus disease	1 2 3 4 5 don't know
Bacterial diseases	1 2 3 4 5 don't know
Fungal leaf disease	1 2 3 4 5 don't know
Fusarium wilt	1 2 3 4 5 don't know
Banana finger diseases	1 2 3 4 5 don't know
F) Research on pest control and management (excl. res.nt varieties)	
Insect pests of bunch and fingers	1 2 3 4 5 don't know
Banana weevils	1 2 3 4 5 don't know
Nematodes	1 2 3 4 5 don't know
Weeds	1 2 3 4 5 don't know
G) Research on value chains, postharvest utilization and marketing	
Improve shelf life of bananas	1 2 3 4 5 don't know
Improve small scale processing of bananas for human consumption	1 2 3 4 5 don't know
Alternative on-farm utilization/processing for value addition	1 2 3 4 5 don't know
Develop (new) bananas products for human consumption	1 2 3 4 5 don't know
Develop (new) bananas products for industrial applications (puree, flour and starch)	1 2 3 4 5 don't know
Develop (new) bananas products for animal feed	1 2 3 4 5 don't know
Ethanol production from bananas	1 2 3 4 5 don't know
Improve management of residues	1 2 3 4 5 don't know
Develop competitive bananas value chains	1 2 3 4 5 don't know
Research on more gender equitable value chains	1 2 3 4 5 don't know
Develop farmer organizations/farmer clusters linked to markets	1 2 3 4 5 don't know
H) Socioeconomic / policy research and impact studies	1 2 3 4 5 don't know
Research on small farmer access to new technologies	1 2 3 4 5 don't know
Research on banana technology adoption	1 2 3 4 5 don't know
Research on banana-based innovation systems	1 2 3 4 5 don't know
Assess impact of bananas research and development	1 2 3 4 5 don't know
Research on health and environmental risks of herbicide and pesticide use in	1 2 3 4 5 don't know

	Importance 1=not important, 2=somewhat important, 3=important, 4=very important, 5=extremely important
bananas systems	
Research on health effects of bio-fortified bananas varieties	1 2 3 4 5 don't know
Study gender inequality in bananas production systems	1 2 3 4 5 don't know
Research on relevant food and agricultural policies	1 2 3 4 5 don't know
Research to improve policy framework for banana cultivars and planting materials (distribution, regulations, IPRs, etc.)	1 2 3 4 5 don't know
I) Extension research	
Develop new extension strategies	1 2 3 4 5 don't know
Develop new training materials	1 2 3 4 5 don't know

You just completed filling Section B on constraints to '[repeat selected cultivar and crop association]' in one specific region. Do you have expertise in another banana production system or for the same system in a different region and would be willing to answer the previous 5 questions for that system or region?

Yes (please fill the supplement) No (please proceed with question B6)

B6. In the previous question you rated research priorities one by one and by production system. In this last question, please rate the relative importance of different types of banana research overall. In your opinion, what should banana research focus on over the next 10 years to best help reduce poverty and improve food security?

Please read the entire list before starting to allocate points. Then please allocate a total of 120 points, give 0 points to research areas you feel are of no or negligible importance (or just leave fields blank). Please ensure that the research area you consider being most important has the highest number of points and areas of similar importance have the same amount of points.

	Importance (allocated points)

Genetic resource management research	
Breeding for higher yield	
Breeding for improved quality	
Breeding for biotic stress resistance	
Breeding for abiotic stress resistance	
Crop management and production system research	
Planting material and seed system research	
Research on disease and pest management (excl. resistant varieties)	
Research on postharvest handling and processing technology	
Value chain and marketing research	
Socioeconomic research	
Policy-oriented research	
Research on extension strategies, tools and materials	
Other research areas (specify)	
TOTAL	<i>(=120 Points)</i>

Section C. Please tell us a little about yourself

C1. What is your name (response optional, for sharing survey results): _____

C2. What is your e-mail address (response optional): _____

C3. What is your gender (please select one category): male female

C4. What is your age (please select one category):

<25 25-30 31-45 45-65 > 65 years

C5. How many years have you been involved in banana research, development or extension?
(please select one category):

<1 year 1-5 years 6-15 years > 15 years

C6. What is your background? (please select all that apply)

Crop genetic resources Plant breeding and conventional genetics

- | | |
|---|---|
| <input type="checkbox"/> Participatory plant breeding | <input type="checkbox"/> Transgenic research |
| <input type="checkbox"/> Genomics, molecular biology | <input type="checkbox"/> Bioinformatics |
| <input type="checkbox"/> Tissue culture | <input type="checkbox"/> Seed systems & virus management |
| <input type="checkbox"/> Soils/nutrient management | <input type="checkbox"/> Cropping/farming systems |
| <input type="checkbox"/> Water management in crop production | <input type="checkbox"/> Crop management, agronomy, and physiology |
| <input type="checkbox"/> Crop diseases and disease management | <input type="checkbox"/> Crop pests and pest management |
| <input type="checkbox"/> Weed management | <input type="checkbox"/> Economics or policy |
| <input type="checkbox"/> Cultural anthropology or rural sociology | <input type="checkbox"/> Monitoring and evaluation |
| <input type="checkbox"/> Training and knowledge management | <input type="checkbox"/> Technology dissemination/transfer |
| <input type="checkbox"/> Nutrition | <input type="checkbox"/> Value chain development & management |
| <input type="checkbox"/> Climate change | <input type="checkbox"/> Postharvest crop utilization and marketing |
| <input type="checkbox"/> Research planning and administration | <input type="checkbox"/> Development planning and administration |
| <input type="checkbox"/> Other (please specify): _____ | |

C7. How did you hear about this survey? (please select all that apply)

- ProMusa webpage or newsletter
- Regional banana network (e.g. BAPNET, BARNESA, Innovate Plantain, MUSALAC)
- RTB webpage or newsletter
- Personal email invitation
- From a colleague
- Other (please specify) _____

Please insert any comments in the space below:

THANK YOU VERY MUCH FOR YOUR COLLABORATION!

ANNEX 3. LIST OF REGIONAL NETWORK MEMBER COUNTRIES AND CONTACTS

BARNESA

Burundi (14)
 DR Congo (10)
 Ethiopia (8 + 4 Ensete)
 Kenya (10)
 Madagascar
 Mozambique (7)
 Malawi (9)
 Rwanda (13)
 South Africa (4)
 Sudan (10)
 Tanzania (12)
 Uganda (34 + 19 IITA & Bioversity)

MUSALAC

Argentina (6)
 Bolivia
 Brazil (17)
 Colombia (51)
 Costa Rica (29)
 Cuba (15)
 Dominican Republic (26)
 Ecuador (19)
 Honduras
 Jamaica
 Mexico (13)
 Nicaragua (21)
 Panama (
 Peru (10)
 Puerto Rico (22)
 Venezuela (47)
 [Caribbean States (12)]

BAPNET

Australia
 Bangladesh (5)
 Cambodia
 China
 India (45)
 Indonesia
 Malaysia (5)
 Pacific Countries (9)
 Papua New Guinea (5)
 Philippines (59)
 Sri Lanka (11)
 Taiwan (8)
 Thailand
 Vietnam (10)

Innovate Plantain

Cameroon (11 + 1 Benin + 1 Togo + 2 Guinée
 + 1 Central African Republic)
 DR Congo (3 + 27)
 Cote d'Ivoire (6 + 19)
 Ghana (4)
 Nigeria (20)

Note: Green font for countries which sent expert contacts (and number of contacts provided in brackets).

ANNEX 4. PRIORITIZATION OF BANANA RESEARCH OPTIONS (REGIONAL BREAKDOWN)

TABLE 12. PRIORITIZATION OF BANANA RESEARCH OPTIONS FOR GENETIC RESOURCES MANAGEMENT

Research Options	All responses						Total no. responses	Global rank	All regions		LAC	SSA	Asia/P	CGIAR	Male	Female
	Number of responses by rating*					Mean score			s.e. (mean)							
	1	2	3	4	5											
Research on in-situ GR management	30	70	214	189	112	615	47	3.46	0.043	3.57	3.46	3.32	3.04	3.43	3.54	
Research on collection, characterization (incl. DNA fingerprinting), evaluation, documentation (ex situ)	38	87	194	179	109	607	52	3.39	0.046	3.32	3.48	3.36	3.09	3.35	3.49	
Phenotyping of land races in search of high-value traits/new source of tolerance/resistance to stress	20	53	158	225	170	626	27	3.75	0.042	3.72	3.85	3.66	3.85	3.69	3.91	
Molecular screening of land races in search of high-value traits/new source of tolerance/resistance to stress	33	71	172	205	139	620	43	3.56	0.045	3.52	3.66	3.49	3.35	3.48	3.79	
Research on management of intellectual property rights and material transfer agreements	50	150	203	126	71	600	66	3.03	0.046	2.95	2.96	3.23	2.59	2.99	3.12	
Research on better information about genetic resources and improved access to genetic resources	18	71	222	192	102	605	46	3.48	0.041	3.37	3.58	3.49	3.00	3.48	3.46	

*Rating: 1 = not important, 2 = low importance, 3 = important, 4 = very important, 5 = most important; Note: Top ranked option in each category in red font, second to tenth highest ranked options in green font

TABLE 13. PRIORITIZATION OF BANANA RESEARCH OPTIONS FOR CROP GENETIC IMPROVEMENT

Research Options	All responses					Total # responses	Global rank	All regions		LAC	SSA	Asia/P	CGIAR	Male	Female
	Number of responses by rating*							Mean score	s.e. (mean)	Mean score	Mean score	Mean score	Mean score	Mean score	Mean score
	1	2	3	4	5										
Breeding for															
High yield	9	16	99	222	291	637	1	4.21	0.035	4.14	4.40	4.05	4.17	4.25	4.07
Improved processing quality	27	55	150	216	163	611	31	3.71	0.044	3.63	3.77	3.73	3.23	3.69	3.78
Shorter crop cycle	16	78	149	213	158	614	35	3.68	0.043	3.45	3.83	3.77	3.39	3.70	3.62
Higher pro-vitamin A (beta-carotene) content	46	98	189	155	98	586	57	3.27	0.048	2.99	3.49	3.37	2.70	3.19	3.52
Better retention of micronutrients during processing & storage	52	94	173	168	82	569	58	3.24	0.049	2.94	3.47	3.29	2.86	3.16	3.44
Delayed ripening/longer shelf life	19	69	135	195	160	578	33	3.71	0.046	3.56	3.69	3.92	3.26	3.68	3.79
Resistance to virus disease (BBTV, BSV)	21	54	120	161	194	550	19	3.82	0.048	3.51	4.05	3.95	3.98	3.82	3.83
Resistance to fungal leaf diseases	4	21	96	144	200	465	3	4.11	0.044	4.45	3.82	3.85	3.71	4.15	3.95
Resistance to bacterial diseases	21	38	99	147	149	454	23	3.80	0.053	3.87	3.94	3.59	3.30	3.77	3.90
Resistance to nematodes	12	42	124	142	133	453	26	3.75	0.050	3.85	3.95	3.41	3.56	3.79	3.61
Resistance to weevils	13	51	121	142	116	443	38	3.67	0.051	3.62	3.95	3.44	3.29	3.68	3.63
Resistance to Fusarium	25	32	86	122	176	441	12	3.89	0.056	3.95	3.63	4.06	3.85	3.89	3.89
Drought tolerance/water-use efficiency	15	28	112	139	156	450	16	3.87	0.050	3.96	3.85	3.75	3.34	3.87	3.87
Cold tolerance/highland hardiness	88	111	95	66	47	407	71	2.69	0.064	2.62	2.57	2.92	2.55	2.67	2.75

*Rating: 1=not important, 2=low importance, 3=important, 4=very important, 5=most important. Note: Top ranked option in each category in red font, second to tenth highest ranked options in green font.

TABLE 13. PRIORITIZATION OF BANANA RESEARCH OPTIONS FOR CROP GENETIC IMPROVEMENT (CONTINUED)

Research Options	All responses					Total no. responses	Global rank	All regions		LAC	SSA	Asia/P	CGIAR	Male	Female
	Number of responses by rating*							Mean score	s.e. (mean)	Mean score	Mean score	Mean score	Mean score	Mean score	
	1	2	3	4	5										
Breeding for															
Heat tolerance	54	115	109	77	56	411	67	2.92	0.061	2.96	2.70	3.06	2.21	2.87	3.12
Tolerance to waterlogging	39	88	128	86	64	405	62	3.12	0.060	3.18	2.64	3.47	2.22	3.06	3.32
Tolerance to marginal/saline soils	39	104	114	92	52	401	65	3.03	0.059	3.04	2.84	3.22	2.00	2.98	3.21
Improved nutrient-use efficiency	7	24	109	155	124	419	17	3.87	0.047	4.05	3.72	3.75	3.31	3.88	3.80
Other crop improvement research															
Germplasm enhancement and pre-breeding	16	54	145	101	72	388	48	3.41	0.054	3.24	3.64	3.45	3.07	3.45	3.28
Exploitation of heterosis	21	81	130	85	39	356	63	3.11	0.056	3.08	3.06	3.21	2.62	3.11	3.13
Flowering ability/botanic seed production	46	107	109	76	30	368	70	2.83	0.059	2.94	2.71	2.77	2.47	2.78	2.96
Improved accelerated breeding methods	16	42	128	124	93	403	42	3.59	0.054	3.66	3.64	3.42	3.10	3.62	3.46
Exploitation of molecular markers	24	53	124	118	68	387	50	3.40	0.057	3.48	3.31	3.36	2.90	3.38	3.40

*Rating: 1 = not important, 2 = low importance, 3 = important, 4 = very important, 5 = most important. Note: Top ranked option in each category in red font, second to tenth highest ranked options in green font.

TABLE 14. PRIORITIZATION OF BANANA RESEARCH OPTIONS FOR PRODUCTION TECHNOLOGY, AGRONOMY, CROP MANAGEMENT AND PLANTING MATERIAL RESEARCH

Research Options	All responses Number of responses by rating*					Total no. responses	Global rank	All Regions		LAC Mean score	SSA Mean score	Asia/P Mean score	CGIAR Mean score	Male Mean score	Female Mean score
	1	2	3	4	5			Mean score	s.e. (mean)						
Production technology, agronomy, crop management research															
Strategies to improve soil fertility (micronutrients and fertilizer)	2	14	99	145	166	426	4	4.08	0.043	4.18	4.18	3.82	4.03	4.12	3.89
Strategies to manage soil acidity	12	67	149	120	62	410	53	3.37	0.050	3.36	3.52	3.26	3.35	3.42	3.19
Strategies to manage soil salinity	30	86	130	106	48	400	61	3.14	0.056	3.13	3.04	3.23	2.52	3.11	3.17
Strategies to manage microbes/ microbial communities for soil, root, and plant health	6	20	108	162	118	414	13	3.88	0.046	4.07	3.61	3.85	3.97	3.87	3.90
Strategies to improve water management in crop production	7	29	116	148	117	417	20	3.81	0.048	3.88	3.76	3.75	3.32	3.78	3.91
Improving banana monocropping systems	16	35	126	148	95	420	40	3.65	0.051	3.82	3.36	3.63	3.06	3.69	3.43
Optimizing banana production in mixed systems with annual food crops or perennial crops	14	44	126	135	91	410	41	3.60	0.052	3.56	3.74	3.52	3.73	3.57	3.71
Strategies to improve weed management and control	11	67	159	124	56	417	54	3.35	0.048	3.34	3.31	3.41	2.88	3.40	3.13
Planting material research															
Methods for improved phytosanitary and physiological quality of planting material	4	20	99	137	155	415	5	4.01	0.046	4.04	4.07	3.92	3.94	4.04	3.88
Improved methods for production and distribution of elite planting materials (formal seed system)	5	22	97	149	140	413	7	3.96	0.047	3.96	4.16	3.80	4.13	4.01	3.76
Improved methods for farmer based production and distribution of planting materials (informal seed systems)	12	15	110	159	120	416	18	3.87	0.048	3.80	4.07	3.78	3.93	3.88	3.78

*Rating: 1=not important, 2=low importance, 3=important, 4=very important, 5=most important. Top ranked option in each category in red font, 2. – 10. highest ranked options in green font.

TABLE 15. PRIORITIZATION OF BANANA RESEARCH OPTIONS ON DISEASE MANAGEMENT AND PEST CONTROL AND MANAGEMENT (EXCL. RESISTANT VARIETIES)

Research Options	All Responses Number of responses by rating*					Total no. responses	Global rank	All Regions		LAC	SSA	Asia/P	CGIAR	Male	Female
	1	2	3	4	5			Mean score	s.e. (mean)	Mean score	Mean score	Mean score	Mean score	Mean score	Mean score
Research on disease management (excl. resistant varieties)															
Management of virus diseases	6	40	127	124	107	404	32	3.71	0.050	3.58	3.78	3.84	3.79	3.71	3.71
Management of bacterial diseases	9	28	113	138	111	399	25	3.79	0.050	3.78	3.98	3.63	3.55	3.78	3.81
Management of fungal leaf disease	2	11	96	127	170	406	2	4.11	0.044	4.40	3.88	3.85	3.77	4.16	3.91
Management of Fusarium wilt	17	17	84	123	153	394	8	3.96	0.054	4.09	3.71	3.99	4.21	3.94	4.02
Management of banana finger diseases	22	59	129	109	61	380	55	3.34	0.056	3.52	3.06	3.31	2.93	3.30	3.48
Research on pest control and management (excl. resistant varieties)															
Management of insect pests of bunch and fingers	18	69	123	113	77	400	49	3.41	0.056	3.51	3.08	3.55	2.83	3.37	3.52
Management of banana weevils	7	41	114	144	90	396	36	3.68	0.050	3.66	3.84	3.56	3.17	3.69	3.62
Management of nematodes	7	44	110	132	104	397	30	3.71	0.052	3.82	3.93	3.31	3.31	3.76	3.51
Management of weeds	17	77	143	104	46	387	60	3.22	0.053	3.17	3.23	3.29	2.59	3.26	3.04

*Rating: 1 = not important, 2 = low importance, 3 = important, 4 = very important, 5 = most important. Note: Top ranked option in each category in red font, second to tenth highest ranked options in green font.

TABLE 16. PRIORITIZATION OF BANANA RESEARCH OPTIONS ON VALUE CHAIN, POSTHARVEST UTILIZATION, AND MARKETING RESEARCH

Research Options	All Responses					Total no. responses	Global rank	All Regions		LAC	SSA	Asia/P	CGIAR	Male	Female
	Number of responses by rating*							Mean score	s.e. (mean)	Mean score	Mean score	Mean score	Mean score	Mean score	Mean score
	1	2	3	4	5										
Improving shelf life of bananas	12	34	85	140	139	410	15	3.88	0.052	3.74	3.98	3.99	3.42	3.87	3.91
Improving small scale processing of bananas for human consumption	13	33	123	153	92	414	37	3.67	0.050	3.74	3.98	3.99	3.24	3.66	3.73
Alternative on-farm utilization/ processing for value addition	12	30	130	147	87	406	39	3.66	0.049	3.55	3.81	3.71	3.03	3.61	3.83
Develop (new) banana products for human consumption	9	33	115	146	105	408	28	3.75	0.050	3.62	3.77	3.61	3.23	3.71	3.89
Develop (new) banana products for industrial applications (puree, flour and starch)	13	34	124	125	108	404	34	3.70	0.052	3.73	3.78	3.76	2.97	3.64	3.92
Develop (new) banana products for animal feed	26	80	132	104	58	400	59	3.22	0.056	3.69	3.76	3.64	2.35	3.15	3.48
Ethanol production from bananas	66	99	110	67	52	394	69	2.85	0.064	3.37	3.17	3.03	1.97	2.81	3.00
Improve management of residues	15	52	125	126	72	390	45	3.48	0.054	2.88	2.93	2.72	3.19	3.43	3.68
Development of competitive banana value chains	3	24	125	145	98	395	24	3.79	0.046	3.62	3.38	3.38	3.87	3.75	3.91
Research on more gender equitable value chains	26	81	141	86	40	374	64	3.09	0.055	3.71	3.75	3.94	2.94	3.05	3.27
Develop farmer organizations/ farmer clusters linked to markets	4	24	128	131	112	399	21	3.81	0.047	3.15	3.25	2.85	3.97	3.82	3.77

*Rating: 1 = not important, 2 = low importance, 3 = important, 4 = very important, 5 = most important. Note: Top ranked option in each category in red font, second to tenth highest ranked options in green font.

TABLE 17. PRIORITIZATION OF BANANA RESEARCH OPTIONS ON SOCIOECONOMIC, POLICY, AND EXTENSION RESEARCH AND IMPACT STUDIES

Research Options	All Responses Number of responses by rating*					Total no. responses	Global rank	All Regions		LAC	SSA	Asia/P	CGIAR	Male	Female
	1	2	3	4	5			Mean score	s.e. (mean)	Mean score	Mean score	Mean score	Mean score	Mean score	Mean score
Socioeconomic and policy research and impact studies															
Research on small farmer access to new technologies	5	18	104	155	122	404	9	3.92	0.046	3.93	3.97	3.87	3.73	3.90	3.95
Research on technology adoption	4	12	103	155	130	404	6	3.98	0.044	3.99	4.04	3.91	3.66	3.96	4.01
Research on banana-based innovation systems	1	15	111	172	96	395	14	3.88	0.042	3.95	3.91	3.77	3.70	3.88	3.86
Assess impact of banana R&D	3	24	113	155	95	390	22	3.81	0.046	3.77	3.93	3.76	3.53	3.77	3.94
Assess health and environmental risks of herbicide and pesticide use in bananas systems	10	41	99	143	104	397	29	3.73	0.052	4.05	3.52	3.47	2.87	3.72	3.75
Assess health effects of biofortified bananas varieties	28	47	120	131	62	388	51	3.39	0.056	3.46	3.33	3.37	2.57	3.39	3.39
Study gender inequality in bananas production systems	36	99	143	70	28	376	68	2.88	0.055	2.96	2.95	2.70	2.68	2.88	2.91
Research on relevant food and agricultural policies	11	65	153	100	55	384	56	3.32	0.051	3.37	3.39	3.19	3.07	3.35	3.21
Research to improve policy framework for banana cultivars and planting material (distribution, regulation, IPRs)	12	39	135	117	77	380	44	3.55	0.053	3.49	3.71	3.50	3.33	3.57	3.43
Extension research															
Develop new extension strategies	3	19	114	135	127	398	10	3.91	0.046	4.00	4.04	3.67	3.97	3.92	3.90
Develop new extension training materials	2	18	106	155	114	395	10	3.91	0.044	4.03	3.92	3.73	3.93	3.92	3.86

*Rating: 1 = not important, 2 = low importance, 3 = important, 4 = very important, 5 = most important. Note: Top ranked option in each category in red font, second to tenth highest ranked options in green font.

ANNEX 5. PRIORITIZATION OF BANANA RESEARCH OPTIONS (BY CULTIVAR GROUPS AND SUB-REGIONS)

TABLE 18. PRIORITIZATION OF BANANA RESEARCH OPTIONS FOR GENETIC RESOURCES MANAGEMENT (BY CULTIVAR GROUPS AND SUB-REGIONS)

Research Options	Global Rank	Major Cultivar Groups												
		All regions			Africa			Asia/Pacific			Cavendish AAA	EAHB AAA	Plantain AAB	ABB Cooking Bananas
		Mean score	s.e. (mean)	Mean score	Mean score	Mean score	Mean score	Mean score	Mean score	Mean score	Mean score	Mean score	Mean score	
Research on in-situ GR management	47	3.46	0.043	3.42	3.49	3.50	2.97	3.41	3.40	3.33	3.48	3.55	3.50	
Research on collection, characterization (incl. DNA fingerprinting), evaluation, documentation (ex situ)	52	3.39	0.046	3.26	3.65	3.48	3.09	3.47	3.28	3.26	3.58	3.30	3.57	
Phenotyping of land races in search of high-value traits/new source of tolerance/resistance to stress	27	3.75	0.042	3.80	3.96	3.52	3.57	3.64	3.88	3.63	4.02	3.82	3.72	
Molecular screening of land races in search of high-value traits/new source of tolerance/ resistance to stress	43	3.56	0.045	3.37	3.91	3.57	3.42	3.51	3.48	3.51	3.88	3.50	3.54	
Research on management of intellectual property rights and material transfer agreements	66	3.03	0.046	2.64	3.23	2.82	3.18	3.29	3.08	3.09	3.21	2.85	2.93	
Research on better information about genetic resources and improved access to genetic resources	46	3.48	0.041	3.40	3.67	3.85	3.39	3.52	3.46	3.41	3.68	3.44	3.46	

*Rating: 1 = not important, 2 = low importance, 3 = important, 4 = very important, 5 = most important. Note: Top ranked option in each category in red font, second to tenth highest ranked options in green font.

TABLE 19. PRIORITIZATION OF BANANA RESEARCH OPTIONS FOR CROP GENETIC IMPROVEMENT (BY CULTIVAR GROUPS AND SUB-REGIONS)

Research Options	Global Rank	Major Cultivar Groups											
		All regions		Africa			Asia/Pacific			Cavendish AAA	EAHB AAA	Plantain AAB	ABB Cooking Bananas
		Mean score	Mean score	WCA Mean score	EA Mean score	SA Mean score	SAs Mean score	SEA Mean score	Pacific Mean score	Mean score	Mean score	Mean score	Mean score
Breeding for													
High yield	1	4.21	0.035	4.39	4.42	4.35	3.86	4.14	3.92	4.04	4.45	4.34	4.16
Improved processing quality	31	3.71	0.044	3.58	3.94	3.70	3.68	3.85	3.25	3.58	4.00	3.71	3.86
Shorter crop cycle	35	3.68	0.043	3.77	3.82	4.20	3.86	3.83	3.33	3.56	3.90	3.70	3.82
Higher pro-vitamin A (beta-carotene) content	57	3.27	0.048	3.35	3.59	3.52	3.32	3.45	3.04	3.03	3.63	3.29	3.54
Better retention of micronutrients during processing & storage	58	3.24	0.049	3.29	3.69	3.05	3.09	3.47	2.77	2.95	3.66	3.29	3.44
Delayed ripening/longer shelf life	33	3.71	0.046	3.56	3.78	3.78	4.03	4.02	3.16	3.79	3.68	3.60	3.56
Resistance to virus disease (BBTV, BSV)	19	3.82	0.048	4.10	4.00	4.10	3.94	3.97	3.80	3.69	4.04	3.89	3.78
Resistance to fungal leaf diseases	3	4.11	0.044	3.77	3.86	3.83	3.96	3.76	4.13	4.32	3.98	4.20	3.47
Resistance to bacterial diseases	23	3.80	0.053	3.48	4.41	3.67	3.07	3.72	3.80	3.69	4.51	3.81	3.74
Resistance to nematodes	26	3.75	0.050	3.91	3.94	4.25	3.22	3.38	3.93	3.63	4.00	4.10	3.43
Resistance to weevils	38	3.67	0.051	3.93	3.94	4.08	3.32	3.42	3.73	3.44	4.06	3.97	3.57
Resistance to Fusarium	12	3.89	0.056	3.37	3.75	4.17	3.43	4.27	4.07	3.99	3.70	3.54	3.97
Drought tolerance/ water-use efficiency	16	3.87	0.050	3.65	3.92	4.42	3.83	3.80	3.33	3.91	3.92	3.90	3.76
Cold tolerance/highland hardiness	71	2.69	0.064	2.22	2.63	3.67	2.67	2.99	3.00	2.88	2.60	2.42	2.53

*Rating: 1=not important, 2=low importance, 3=important, 4=very important, 5=most important. Note: Top ranked option in each category in red font, second to tenth highest ranked options in green font.

TABLE 19. PRIORITIZATION OF BANANA RESEARCH OPTIONS FOR CROP GENETIC IMPROVEMENT (BY CULTIVAR GROUPS AND SUB-REGIONS), CONTINUED

Research Options	Global Rank	Major Cultivar Groups											
		All Regions		Africa			Asia/Pacific			Cavendish AAA	EAHB AAA	Plantain AAB	ABB Cooking Bananas
		Mean score	Mean score	WCA Mean score	EA Mean score	SA Mean score	SAs Mean score	SEA Mean score	Pacific Mean score	Mean score	Mean score	Mean score	Mean score
Breeding for													
Heat tolerance	67	2.92	0.061	2.62	2.60	3.55	2.96	3.06	3.20	2.98	2.46	2.81	3.17
Tolerance to waterlogging	62	3.12	0.060	2.78	2.33	3.55	2.92	3.60	3.67	3.22	2.05	3.00	3.51
Tolerance to marginal and/or saline soils	65	3.03	0.059	2.66	2.91	3.27	3.17	3.17	3.53	3.02	2.84	2.95	3.42
Improved nutrient-use efficiency	17	3.87	0.047	3.47	3.84	4.17	3.73	3.77	3.62	3.88	3.81	3.84	3.88
Other crop improvement research													
Germplasm enhancement and pre-breeding	48	3.41	0.054	3.47	3.80	3.58	3.00	3.58	3.54	3.28	3.85	3.41	3.53
Exploitation of heterosis	63	3.11	0.056	2.76	3.36	2.92	3.04	3.23	3.46	3.13	3.32	2.97	3.22
Flowering ability/botanic seed production	70	2.83	0.059	2.60	2.86	2.50	2.61	2.80	2.92	2.81	2.70	2.94	2.87
Improved accelerated breeding methods	42	3.59	0.054	3.46	3.80	3.67	3.16	3.49	3.50	3.64	3.86	3.60	3.42
Exploitation of molecular markers	50	3.40	0.057	3.00	3.58	3.33	2.86	3.57	3.20	3.48	3.68	3.31	3.18

*Rating: 1 = not important, 2 = low importance, 3 = important, 4 = very important, 5 = most important. Note: Top ranked option in each category in red font, second to tenth highest ranked options in green font.

TABLE 20. PRIORITIZATION OF BANANA RESEARCH OPTIONS FOR PRODUCTION TECHNOLOGY, AGRONOMY, AND CROP MANAGEMENT

Research Options	Global Rank	Major Cultivar Groups												
		All regions		Africa			Asia/Pacific				Cavendish	EAHB	Plantain	ABB Cooking
		Mean score	Mean score	WCA	EA	SA	SAs	SEA	Pacific	AAA	AAA	AAB	Bananas	
Production technology, agronomy, crop management research														
Strategies to improve soil fertility (micronutrients and fertilizer)	4	4.08	0.043	4.18	4.19	4.09	4.04	3.75	3.77	4.04	4.29	4.19	3.76	
Strategies to manage soil acidity	53	3.37	0.050	3.48	3.58	3.45	3.00	3.33	3.31	3.29	3.73	3.48	3.37	
Strategies to manage soil salinity	61	3.14	0.056	2.79	3.25	3.18	3.21	3.19	3.54	3.20	3.22	2.96	3.32	
Strategies to manage microbes/ microbial communities for soil, root & plant health	13	3.88	0.046	3.43	3.71	4.00	3.86	3.78	4.23	3.98	3.75	3.76	3.73	
Strategies to improve water management in crop production	20	3.81	0.048	3.44	4.04	3.91	3.89	3.70	3.77	3.82	4.10	3.73	3.79	
Improving banana monocropping systems	40	3.65	0.051	3.53	3.08	3.90	3.89	3.65	3.00	3.81	2.95	3.75	3.61	
Optimizing banana production in mixed systems with annual food crops or perennial crops	41	3.60	0.052	3.76	3.67	4.00	3.07	3.59	4.00	3.31	3.75	3.76	3.76	
Strategies to improve weed mngt./control	54	3.35	0.048	3.46	3.04	3.91	3.62	3.31	3.62	3.42	3.05	3.35	3.43	

*Rating: 1=not important, 2=low importance, 3=important, 4=very important, 5=most important; top ranked option in each category in red font, 2. – 10. highest ranked options in green font

TABLE 21. PRIORITIZATION OF BANANA RESEARCH OPTIONS FOR PLANTING MATERIAL RESEARCH

Research Options	Global Rank	Major Cultivar Groups											
		All regions		Africa			Asia/Pacific			Cavendish	EAHB	Plantain	ABB Cooking
		Mean score	Mean score	WCA	EA	SA	SAs	SEA	Pacific	AAA	AAA	AAB	Bananas
Planting material research													
Methods for improved phytosanitary and physiological quality of planting material	5	4.01	0.046	4.10	4.04	4.09	4.04	3.85	4.07	3.86	4.13	4.14	3.97
Improved methods for production and distribution of elite planting materials (formal seed system)	7	3.96	0.047	4.12	4.12	4.55	3.88	3.75	3.93	3.82	4.15	4.18	3.77
Improved methods for farmer based production and distribution of planting materials (informal seed systems)	18	3.87	0.048	4.04	4.08	4.18	3.83	3.71	4.15	3.57	4.10	4.17	3.74

*Rating: 1=not important, 2=low importance, 3=important, 4=very important, 5=most important; top ranked option in each category in red font, 2. – 10. highest ranked options in green font

**TABLE 22. PRIORITIZATION OF BANANA RESEARCH OPTIONS ON DISEASE MANAGEMENT AND PEST CONTROL AND MANAGEMENT (EXCL. RESISTANT VARIETIES)
BY CULTIVAR GROUPS AND SUB-REGIONS**

Research Options	Global Rank	Major Cultivar Groups												
		All regions		Africa			Asia/Pacific				Cavendish	EAHB	Plantain	ABB Cooking
		Mean score	s.e. (mean)	WCA	EA	SA	SAs	SEA	Pacific	AAA	AAA	AAB	Bananas	Mean score
Research on disease management (excl. resistant varieties)														
Management of virus diseases	32	3.71	0.050	3.78	3.71	4.09	3.58	3.91	3.86	3.61	3.77	3.78	3.69	
Management of bacterial diseases	25	3.79	0.050	3.51	4.40	4.00	3.48	3.67	3.69	3.67	4.59	3.79	3.85	
Management of fungal leaf disease	2	4.11	0.044	3.79	3.90	4.18	3.84	3.78	4.21	4.24	4.08	4.15	3.72	
Management of Fusarium wilt	8	3.96	0.054	3.51	3.75	4.36	3.61	4.08	4.14	4.00	3.79	3.78	3.82	
Management of banana finger diseases	55	3.34	0.056	3.07	2.96	3.50	2.68	3.47	3.43	3.44	3.00	3.29	3.41	
Research on pest control and management (excl. resistant varieties)														
Management of insect pests of bunch and fingers	49	3.41	0.056		3.04	3.91	3.16	3.63	3.79	3.57	3.10	3.22	3.50	
Management of banana weevils	36	3.68	0.050	3.85	3.80	4.00	3.67	3.52	3.57	3.53	3.93	3.93	3.59	
Management of nematodes	30	3.71	0.052	3.85	3.88	4.50	3.36	3.21	3.79	3.60	3.90	4.02	3.55	
Management of weeds	60	3.22	0.053	3.26	3.06	3.82	3.38	3.24	3.36	3.23	3.05	3.29	3.50	

*Rating: 1 = not important, 2 = low importance, 3 = important, 4 = very important, 5 = most important. Note: Top ranked option in each category in red font, second to tenth highest ranked options in green font.

TABLE 23. PRIORITIZATION OF BANANA RESEARCH OPTIONS ON VALUE CHAIN, POSTHARVEST UTILIZATION, AND MARKETING BY CULTIVAR GROUPS AND SUB-REGIONS

Research Options	Global Rank	Major Cultivar Groups												
		All regions			Africa			Asia / Pacific				Major Cultivar Groups		
		Mean score	s.e. (mean)	WCA	EA	SA	SAs	SEA	Pacific	Cavendish AAA	EAHB AAA	Plantain AAB	ABB Cooking	Mean score
Improving shelf life of bananas	15	3.88	0.052	4.06	3.88	4.09	3.85	4.13	3.46	3.94	3.85	3.85	3.71	
Improving small scale processing of bananas for human consumption	37	3.67	0.050	3.76	3.83	3.91	3.69	3.77	3.42	3.45	3.83	3.87	4.00	
Alternative on-farm utilization/ processing for value addition	39	3.66	0.049	3.75	3.75	3.91	3.42	3.67	3.62	3.48	3.87	3.86	3.91	
Develop (new) banana products for human consumption	28	3.75	0.050	3.72	3.78	4.00	3.60	3.75	4.08	3.70	3.85	3.85	3.94	
Develop (new) banana products for industrial applications (puree, flour and starch)	34	3.70	0.052	3.60	3.80	4.27	3.44	3.65	4.00	3.61	3.93	3.81	3.97	
Develop (new) banana products for animal feed	59	3.22	0.056	2.90	3.29	3.82	2.92	2.97	3.62	3.19	3.34	3.21	3.63	
Ethanol production from bananas	69	2.85	0.064	2.84	2.80	3.91	2.64	2.77	2.57	2.88	2.80	2.81	3.15	
Improve management of residues	45	3.48	0.054	3.37	3.27	3.91	3.54	3.34	3.31	3.51	3.38	3.52	3.72	
Development of competitive banana value chains	24	3.79	0.046	3.69	3.80	3.82	3.83	3.97	3.92	3.73	3.85	3.73	3.94	
Research on more gender equitable value chains	64	3.09	0.055	3.21	3.24	3.50	2.77	2.81	3.23	2.98	3.34	3.19	3.09	
Develop farmer organizations/ farmer clusters linked to markets	21	3.81	0.047	3.96	4.06	4.00	3.88	3.75	3.62	3.60	4.10	3.90	3.76	

*Rating: 1 = not important, 2 = low importance, 3 = important, 4 = very important, 5 = most important. Note: Top ranked option in each category in red font, second to tenth highest ranked options in green font.

TABLE 24. PRIORITIZATION OF BANANA RESEARCH OPTIONS ON SOCIOECONOMIC, POLICY, AND EXTENSION RESEARCH AND IMPACT STUDIES (CULTIVAR GROUPS)

Research Options	Global Rank	Cultivar Groups												
		All regions			Africa		Asia/Pacific				Major Cultivar Groups			
		Mean score	s.e. (mean)	WCA	EA	SA	SAs	SEA	Pacific	Cavendish AAA	EAHB AAA	Plantain AAB	ABB cooking bananas	
Socioeconomic and policy research and impact studies														
Research on small farmer access to new technologies	9	3.92	0.046	3.90	3.94	4.45	4.04	3.87	3.57	3.83	4.00	4.01	3.91	
Research on technology adoption	6	3.98	0.044	3.98	3.94	4.73	4.00	3.95	3.57	3.91	4.00	4.09	4.06	
Research on banana-based innovation systems	14	3.88	0.042	3.83	3.94	4.09	3.79	3.76	3.79	3.76	4.03	3.98	3.88	
Assess impact of banana R&D	22	3.81	0.046	3.85	3.92	4.27	3.87	3.76	3.57	3.68	3.95	3.97	3.74	
Assess health and environmental risks of herbicide/pesticide use in bananas systems	29	3.73	0.052	3.40	3.40	4.55	3.52	3.48	3.29	3.94	3.40	3.80	3.49	
Assess health effects of biofortified bananas	51	3.39	0.056	3.00	3.42	4.18	3.40	3.42	3.07	3.33	3.41	3.44	3.60	
Study gender inequality in bananas production systems	68	2.88	0.055	2.74	3.02	3.55	2.45	2.76	2.79	2.80	3.10	2.97	2.70	
Research on relevant food/agric. policies	56	3.32	0.051	3.09	3.50	4.18	3.18	3.19	3.21	3.33	3.62	3.36	3.12	
Research to improve policy framework for banana cultivars and planting material (distribution, regulation, IPRs)	44	3.55	0.053	3.57	3.78	4.00	3.77	3.41	3.50	3.45	3.82	3.70	3.44	
Extension research														
Develop new extension strategies	10	3.91	0.046	4.02	4.00	4.27	3.83	3.58	3.93	3.79	4.13	4.07	3.76	
Develop new extension training materials	10	3.91	0.044	3.96	3.82	4.27	4.09	3.62	3.77	3.81	3.82	4.13	3.85	

*Rating: 1 = not important, 2 = low importance, 3 = important, 4 = very important, 5 = most important. Note: Top ranked option in each category in red font, second to tenth highest ranked options in green font.

ANNEX 6. EMAIL INVITATION LETTER FOR ONLINE SURVEY (ENGLISH VERSION)

Dear [NAME],

Based on a recommendation from your country's regional banana network representative, we are pleased to **invite you to participate in a global online survey of banana experts.**

In the survey, you will be asked to prioritize the major constraints limiting banana yield and farmers' income in your region and the corresponding research options you think should be pursued. Completing the survey should take you about 20 to 25 minutes.

To start the survey, please follow the link: [URL]

Note: This is your personal link to the online survey (please do not forward to others)

The survey is part of a multi-crop priority assessment exercise coordinated by the **CGIAR Research Program on Roots, Tubers and Bananas (RTB)** to identify the problems scientists should solve first and solutions most likely to have a positive impact on food security and livelihoods. For the banana priority setting, Bioversity International, CIAT, and IITA have teamed up to carry out an impact study in consultation with banana stakeholder from around the world. The study follows a six-step participatory methodology and gives particular emphasis to the needs of poor farmers and other vulnerable groups.

To learn more about the banana priority setting exercise or to follow its progress, please visit the website of your **regional banana research network**, or go directly to the **priority setting section** on the ProMusa website.

Thank you for contributing your time and expertise to help set priorities for future banana research!

Diemuth E. PemsI
(on behalf of the RTB banana priority assessment team)

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