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CIAT’s new strategy is guided by a vision of eco-efficient agriculture underpinned by sound principles and values. The strategy encompasses three elements: research directions, staff, and operations. While this document is mainly concerned with the first element, it is crucial to recall that who we are and how we work are just as important as what we do.

The world has undergone major changes in the 5 years since our last strategy was written – as has CIAT. Through significant internal adjustments, the Center has responded decisively to various external factors, including new developments in CGIAR – the research partnership to which CIAT belongs – and emerging challenges for world agriculture, which have created many new opportunities for the Center and its partners.

The Center has decades of experience in diverse research areas, which will enable us to bring a broad systems perspective to the tasks of reducing hunger and poverty, while improving natural resource management and pro-poor policy in the tropics and subtropics. But we also want to expand our horizons, building new partnerships and embarking on new research in response to new challenges, new ideas, and new developments in science, with the aim of expanding our development impact.

The purpose of CIAT’s strategy is to inspire commitment. We want to inspire our partners and donors – present and future – to join us in building an eco-efficient future. We want to inspire Center staff to achieve our shared goal of a tropical agriculture that offers better lives for people while taking less from the land.

The CGIAR reform resulted in the creation of a strategic research framework together with important new research programs that strongly emphasize outcomes and impact. Since CIAT is involved in many of these programs, our work is closely aligned with the strategic directions set by CGIAR and well integrated with the work of other international centers.

This strategy starts with a description of global and regional trends in agriculture and the challenges and opportunities these trends have created. The document then explains how CIAT research contributes to CGIAR’s research agenda through our three research areas: Agrobiodiversity, Soils, and Decision and Policy Analysis. In describing the future directions of this research, we indicate in quantitative terms some of the key expected outcomes – to be achieved by 2020 or before – which give a clearer sense of the scope and aims of our work.

In addition, we present a set of new strategic initiatives, some of which will serve to pilot new research directions at CIAT,
while others extend the Center’s reach within current research areas. The strategic initiatives will respond to compelling development opportunities by integrating CIAT’s work across our research areas and three regions – sub-Saharan Africa, Asia, and Latin America and the Caribbean. All of the new initiatives will enhance our contributions to CGIAR programs.

Finally, we describe a group of cross-cutting activities that are critical for the implementation of our new strategy. These include efforts to expand our partnerships with key actors in the public and private sectors and civil society, ensure that women and other marginalized people benefit equally from our research, strengthen our partners’ capacity in research for development, enhance knowledge sharing, and foster positive developments in our institutional culture and operations.

Implementing this strategy will require new investments in scientific capacity and innovation. In the coming years, we will deepen and broaden our institutional strengths through the addition of new staff, visiting researchers, and research fellows and the close involvement of donors, governments, scientists, farmers, and rural communities in our research. We will seek out partnerships that leverage new research capacities for our strategic initiatives. We will look for new funding sources, with the aid of pro-active communications, to invest more in our people, our research, and our infrastructure.

The preparation of this document, which was guided by a task force under the leadership of Guy Henry, relied on global consultations, lively internal discussions, and constructive guidance from an independent expert panel. The panel included Fernando Chaparro, Étienne Hainzelin, Brian Keating, Yolanda Kakabadse, Melissa Wood, Masa Iwanaga, Segenet Kelemu, Nguyen Van Bo, Greg Traxler, Joachim von Braun, and Panel Chair Eduardo Trigo. We are extremely grateful to them and to other colleagues for their valuable contributions.

CIAT’s 45th anniversary in 2012 was a happy occasion with much to celebrate. As we move towards the half-century mark, we are excited about using our new strategy as a guide in responding to the important challenges and opportunities that lie ahead.

Cali, Colombia, February 2014

Ruben G. Echeverría
Director General

Wanda Collins
Chair, Board of Trustees
CIAT’s new strategy, guided by a vision of eco-efficient agriculture, responds to various trends shaping the world today, including population growth, rapid urbanization, extensive land degradation, climate change, and exciting scientific advances. The strategy also takes into account key developments in each of the regions where CIAT works – sub-Saharan Africa, Asia, and Latin America and the Caribbean.

In addressing the challenges and opportunities resulting from major trends, our goal is to improve food security and livelihoods in the tropics and subtropics by helping to make agriculture more competitive, sustainable, and climate smart.

In so doing, we are committed to the values of learning and innovation – for our staff, our partners, and the beneficiaries of our work.

We will implement our strategy in two important ways. First, CIAT’s scientific agenda will feed directly into that of the CGIAR Consortium – the global research partnership to which we belong – as we work toward the Center’s three strategic objectives:

1. Make affordable, high-quality food readily available to the rural and urban poor by boosting agricultural productivity and enhancing the nutritional quality of staple crops.
2. Promote rural income growth by making smallholder agriculture more competitive and market oriented through improvements in agricultural value chains.
3. Provide the means to make a more intensive and competitive agriculture both environmentally sustainable and climate smart.

In pursuit of these objectives, which are central for creating upward spirals of sustainable growth, the Center will make significant contributions to CGIAR research. These will result from our efforts to improve four crops (beans, cassava, tropical forages, and rice), advance the sustainable intensification of agriculture, restore degraded land, enhance ecosystem services, link farmers to markets, and confront climate change. Skillful use of new tools for “big data” analysis together with equipment and infrastructure renewal will enhance our work on all these fronts.

Second, CIAT will embark on a set of strategic initiatives designed to boost our development impact, based on the Center’s diverse and evolving research strengths, while also influencing the future focus of CGIAR research. The new initiatives we propose will:
• Promote forage-based livestock production to mitigate greenhouse gas emissions while improving the livelihoods of the rural poor through the sustainable intensification of meat and milk production.
• Develop more sustainable food systems that serve the needs of a rapidly urbanizing world.
• Gain a better grasp of how yield gaps and instability in major crops can be reduced in an eco-efficient manner.
• Enhance ecosystem services in agricultural landscapes as a means to improve the livelihoods and well-being of the rural poor.

In delivering our strategy, we will strive to integrate actions in all of our research areas, both within the context of CGIAR research programs and through our new strategic initiatives. We will vigorously pursue new alliances – including public-private partnerships – and reinforce our current collaboration to ensure the delivery of development impacts in our focus regions. We will take steps to ensure that our work empowers and transforms the lives of women and marginalized groups. We will build stronger capacity for research and innovation among our partners in developing countries. We will mainstream knowledge-sharing principles and practices into our work to enhance our research outcomes through continuous learning.

Finally, in keeping with our vision of an eco-efficient future, we will pursue this aim in CIAT’s own operations, making the Center carbon neutral in the near future and registering further gains during the years to come.

While CIAT’s strategy is aspirational – and, we hope, inspirational – we fully believe that it is achievable. To reinforce this belief, we have included in the strategy a number of measurable outcomes in relation to our strategic objectives and research activities.

The task of building an eco-efficient future for tropical agriculture is just beginning. As this new future takes shape, millions of people across the tropics will see marked improvement in their food security and livelihoods as a result of CIAT’s work.
The success of CIAT’s efforts to strengthen tropical agriculture will depend on our ability to understand and respond to a changing world.

**Global trends**

Over the next decade, diverse trends will impinge on agricultural research for development, including population, income, and poverty dynamics; growing pressure on natural resources; climate change; evolving food systems; and new science.

**Population and poverty**

Population increases continue to be a major force shaping food demand (Figure 1). While the annual rate of growth in world population is expected to decline significantly – from 1.1% at present to 0.4% in 2050 – many developing countries will see large population increases. Population dynamics will follow the current trend towards urbanization. By 2025, the total rural population will peak and then start to decline; food insecurity will become an increasingly urban phenomenon.

Despite poverty reduction in many countries over the past 2 decades, there are still more than 2.6 billion people who earn less than US$2 a day, and close to 1 billion suffer from chronic hunger and malnutrition. At least 70% of the world’s poorest people live in rural areas. The urban poor already surpass the rural poor in absolute numbers, but rural areas still hold a greater percentage of the world’s extremely poor people.

The livelihoods of poor rural households are highly diverse. While non-farm income sources are gaining importance, agriculture continues to play a vital role in most countries, where the poorest households depend heavily on farming and agricultural labor.

**Figure 1. Long-term growth in world population**
Natural resource degradation

The growing human population has put tremendous pressure on agricultural land and water as well as forest, fishery, and biodiversity resources. This pressure threatens the earth’s ecological functions and undermines farmers’ livelihoods, particularly those of the very poor, many of whom make a living from the goods and services provided by natural resources.

While competition over natural resources for food and non-food uses is hardly new, the competition has become significantly more intense in the last decade. This trend will continue, as demand for biomass production continues to grow. Renewable energy, including biomass, contributed to an estimated 16% of total energy needs in 2011, and this is projected to increase.

Alarming rates of natural resource degradation directly impact the extent of productive land available for agriculture (Figure 2). Over the past 50 years, land and soil degradation has reduced crop yields and the agricultural share of gross domestic product by as much as 10%. Meanwhile, the world is losing 24 billion tons of fertile topsoil every year. And about 25% of the world’s freshwater storage capacity will be lost in the next 25–50 years as a result of sedimentation.

Figure 2. Reduction in agriculturally usable land per capita (1961–2008)

Climate change

Climate change is now recognized as the major environmental challenge facing the planet (Figure 3). The most recent report of the Intergovernmental Panel on Climate Change (IPCC) determined that the change in global surface temperature is likely to exceed 1.5 degrees Celsius by the end of the 21st century, relative to its pre-industrial level. Global mean sea level rise for 2081–2100 could be between 26 centimeters (at the low end) and 82 centimeters (at the high end), depending on the greenhouse gas emissions path. The IPCC held that it is “extremely likely” that human influence has been the dominant cause of observed warming since 1950.
Climate change will have significant negative impacts on agriculture in developing countries as a result of more frequent extreme weather events; shifting rainfall patterns; changing distribution of pests and diseases; declining crop quality due to shorter growing seasons; and higher temperatures. These impacts pose a particular threat to food security in poor countries, which are already food insecure. At the same time, agriculture will continue to be a major contributor to climate change through the emission of greenhouse gases. No credible effort to address climate change can afford to ignore agriculture, yet agricultural systems are ill-equipped to deal with the immense changes that lie ahead.

**Food systems**

The evolution of food production systems in recent decades has been characterized by the increased integration of agriculture, fishery, and forestry with other economic activities. Complex and diverse agro-industrial production chains have emerged, which imply qualitative and quantitative changes in the demand for primary products as well as income distribution across sectors and population groups.

The distribution of productive resources has also changed, with the increasing presence of large-scale primary producers along with small-scale operations, particularly in Latin America, Eastern Europe, Central Asia, Southeast Asia, and some parts of sub-Saharan Africa. In many cases, these developments mean new opportunities for economic growth, but they can also result in the displacement of local firms and create difficulties for small primary producers, who may be unable to meet quantity demands and more stringent quality standards.

**New science and technology**

Science has created major opportunities for agriculture in recent years, and this trend is likely to grow in the future. The convergence of new biological, information, and
communications technologies with the engineering sciences is creating new options, not only to reverse the recent slowing of growth in crop yield but also to provide effective technological solutions to climate change and natural resource degradation.

New resources are needed to achieve those goals. Although public investment in agricultural research and development has grown worldwide from about US$16 billion in 1981 to $32 billion in 2008 (Figure 4), private sector investment has grown faster to reach $18 billion in 2008 or 21% of the total. The latest reports also show that public spending on agricultural research and development in China, India, and Brazil – the three top-ranked countries in terms of this spending in the developing world – accounted for one-quarter of global spending and half of combined spending in developing countries. A new divide is opening up between countries on the basis of their access to new technology.

Figure 4. Increased national spending on global agricultural research and development (2000–2008)

Regional trends

The orientation of CIAT’s future research will take into account key developments in each of the regions where we work.

Sub-Saharan Africa

By 2030, Africa’s human population is projected to reach 1.3 billion, with 50% living in cities. While the demand for food is increasing rapidly, supplies remain insufficient or are even declining. Africa is home to about 27% of the world’s 870 million undernourished people, and malnutrition leads to stunted growth among 40% of the region’s children under the age of five.

Food and nutrition security is further compromised by climate change impacts and soil degradation. Land degradation affects 67% of Africa’s agricultural area, with about 490 million hectares experiencing erosion and declining vegetation. Soil nutrient
depletion is a particular concern in this region. Overall, farmers lose 8 million tons of soil nutrients each year, estimated to be worth US$4 billion.

In response to those challenges, major initiatives are underway to promote agricultural development and economic growth in the region, which offer important opportunities to strengthen food security and reverse land degradation.

**Asia**

As a result of major economic development in recent decades, average household wealth has greatly increased in this region, though inequities persist between and within countries. There are large numbers of urban and peri-urban poor, but many of the poorest people live in marginalized rural communities.

Agriculture continues to be an important component of Asian economies, despite rapid growth in other sectors. The cassava and livestock sectors are very dynamic, driven by increasing local, regional, and global demand. Economic growth in the region has created opportunities for agriculture but also major challenges.

Mounting population pressure together with unsustainable agricultural practices, including slash-and-burn agriculture and overgrazing, have resulted in widespread land degradation. Another major threat is the pressure on land for non-agricultural uses and land grabbing by large companies or even other countries to divert land used by smallholders to large-scale agricultural production. The region is also highly vulnerable to climate change.

**Latin America and the Caribbean**

The agricultural sector in Latin America and the Caribbean (LAC) has proved highly dynamic in recent decades, raising its contribution to the value of global agricultural production from 10% in 1960 to 13% in 2010. At the same time, LAC has achieved wide recognition as a major provider of global environmental goods, such as biodiversity and water.

In the years to come, the region will likely strengthen its role as a major food exporter (Figure 5). In addition, its agricultural production systems will become more diverse, with emphasis on value-added crops, such as fruits and other horticultural species as well as medicinal plants and functional foods. Countries of the region that have opted for more open trading arrangements will need to make a concerted effort to ensure that key agricultural value chains become internationally competitive.

The pace of progress in agriculture will depend on how effectively the region can address a number of challenges. Climate change, for example, will affect the entire region, but particularly Central America and the Caribbean. In large part, this is because natural resource degradation in those areas has made them especially
vulnerable: higher temperatures and changes in rainfall patterns could change the entire agricultural landscape, putting the future of millions of farmers at risk.

In many countries, the institutional capacity to support agricultural development is limited, and current policies are insufficient to stimulate investment and growth in the agricultural sector. Despite those limitations, agriculture remains a key driver of economic and social development in most countries of LAC, and the rest of the world increasingly sees the region as a breadbasket for the world.

**Key challenges**

Against this background of global and regional developments, CIAT’s future work will address three key challenges.

1. **Responding to increased food demand, changing consumption patterns, and widespread malnutrition**

Population increases, coupled with improvements in income, will lead to an estimated 70% rise in the total global demand for food by 2050. Rapid urbanization in developing countries will affect this demand significantly, prompting larger numbers of consumers to buy more meat, milk, fruits, and vegetables.

A further consequence of the demand for more varied diets is that, as value chains become more diverse, new opportunities will arise for linking producers with consumers through markets. The elimination of large crop losses and food waste along value chains could help significantly to meet demand without putting further pressure on natural resources. Recent estimates show that almost one-third of all food produced worldwide – 1.3 billion metric tons – may be lost, ruined, or wasted each year.
Diet-related disorders, such as obesity, diabetes, and cardiovascular disease, are increasing around the world and across the socio-economic spectrum. Many developing countries bear a triple burden of malnutrition, resulting from the combination of under-nutrition; deficits of vitamins, minerals, and other essential nutrients; and over-nutrition due to high consumption of sugars, fats, and salt. Reducing this burden will require renewed emphasis on high-quality, nutritious foods. For rural people, the main challenge will continue to be boosting crop and livestock productivity to enhance incomes. For the urban poor, the central issue will be affordable and stable prices for basic foods. To meet both challenges, CIAT research must:

- Embrace novel breeding strategies to accelerate crop improvement.
- Reduce farm-level yield gaps and instability for target crops.
- Enhance the nutritional quality of crops.
- Make food systems and value chains more efficient, emphasizing the inclusion of small farmers in markets, the reduction of food waste, more efficient processing, employment creation, and urban consumption dynamics.

2. Reversing natural resource degradation while achieving sustainable intensification of agriculture

Recent high-level statements – including the report of the 2012 United Nations Conference on Sustainable Development (Rio+20) and Montpellier Panel Report – emphasize the need to reverse natural resource degradation, while intensifying agriculture.

The effort to achieve those goals must be informed by new thinking. Researchers must realize, for example, that natural resource degradation is a sign of declining ecosystem services in landscapes. The problem is not just biophysical but also has social, economic, and political dimensions. Solving the problem is critical to satisfy the need for more food as well as energy, including biofuels and hydropower.

Restoring degraded resources and avoiding future land degradation requires these actions:

- Improve nutrient- and water-use efficiency in farming systems and reduce yield gaps, while sustaining soil fertility over the long term through eco-efficient agriculture.
- Develop methods for monitoring resources in landscapes to support decision-making, planning, and impact assessment in agricultural development interventions.
- Define pathways for agricultural intensification in farming landscapes, including economic incentive schemes and institutional entry points.
- Support policy and investment decisions through improved assessment of ecosystem services and resilience, rural livelihoods, and tradeoffs between food, water, and energy.
3. Achieving climate-smart agriculture

Future food security depends on achieving continued growth in agricultural productivity, despite agriculture’s vulnerability to the impacts of climate change. The need for adaptation and mitigation in agriculture is now widely accepted. It is also increasingly clear that the whole global food system, not just agriculture, must become climate smart. To achieve this will require strong collective action at the national, regional, and global levels.

Farmers will need to change how and what they produce to adapt to variable climate conditions. This will require that farmers and plant breeders have ready access to crop diversity, much of which is available today in genebanks. Through skillful use of crop diversity, they can develop new varieties that are resilient to flooding, drought, and extreme temperatures, making diversity an extremely valuable weapon in the fight to adapt to climate change.

In addition, farmers will need to adopt new practices that permit more efficient use of water and reduce the impact on soils of flooding, erosion, heavy rains, and high winds. Crop management practices that optimize the use of nutrients (from organic and inorganic fertilizers) and incorporate nitrogen-fixing legumes into crop rotations can also help mitigate the effects of climate change. These efforts must give high priority to mixed crop-livestock systems, since they provide livelihoods for two-thirds of the global population and account for half of world cereal production and a third of all beef and milk output.

The challenge for research is to foster climate change adaptation through actions such as these:

• Breed crop varieties that are adapted to projected future climates and produce higher yields with a reduced environmental footprint, including lower greenhouse gas emissions.
• Develop climate-smart soil management practices, which take into account socio-economic issues through a landscape approach that complements the development of new varieties.
• Engage decision-makers in the creation of databases, tools, and methods that support the design of effective strategies for climate change adaptation (from the local to national scales). High priority should be given to new approaches for climate downscaling, targeting of resilient crops, ex ante impact analysis, and cost/benefit analysis of climate-smart options, always taking into account the impacts of such approaches on women and socially marginalized groups.
Chapter 2

How CIAT contributes to CGIAR research

The concept of eco-efficiency forms the foundation for CIAT’s vision of what agriculture must offer in the future. An eco-efficient agriculture improves the well-being of farmers and poor urban consumers, while also reflecting sensitivity to ecological concerns. The eco-efficiency concept (see box) thus serves as a guide for our contributions to global food security and sustainable agricultural development.

Toward an eco-efficient future
In 2013, CIAT published a book titled Eco-Efficiency: From Vision to Reality, a rigorous examination of the relevance of eco-efficiency to the challenges that tropical agriculture faces today, especially climate change. The book delivers a clear message about the potential role of research on cropping systems and crops in achieving eco-efficient agriculture:

- Agrosilvopastoral systems (combining crops, pastures, and trees); integrated soil fertility management; and conservation agriculture all offer eco-efficient options for managing tradeoffs between agricultural production and resource preservation.
- Appropriate management of tropical forages can stabilize and restore degraded lands and enhance ecosystem services, while helping mitigate climate change and generating huge livelihood benefits.
- Cassava is exceptionally well adapted to environmental stresses and thrives even without high input use but requires strong efforts to thwart disease and pest threats.
- Beans are a nutritional goldmine for the poor but will be especially vulnerable to climate change impacts, unless a major effort is made to find genetic and management solutions that increase adaptability and productivity.
- Rice relies heavily on abundant water, but there are opportunities to develop varieties and production practices that use water more efficiently.

Achieving eco-efficient agriculture will require unflagging commitment to the development and widespread adoption of more productive crop varieties and better practices for managing natural resources. Skillful capacity building and knowledge sharing will be necessary at every level to ensure that eco-efficient agriculture does not bypass smallholder farmers, including women and marginalized groups. Most of CIAT’s research is directly concerned with helping meet these commitments.

CIAT’s principles and values

We believe that an eco-efficient future can be achieved only if it involves meaningful collaboration between farmers, technicians, scientists, and other actors in agricultural innovation. By enhancing the way we work and learn together,
we will empower our staff to support such collaboration and help realize CIAT’s vision of an eco-efficient agriculture. To this end, we have formulated a set of principles and values that reflect the kind of people – and the kind of center – we want to be:

**Shared organizational ethic.** We respect each other, our partners, and the people who benefit from our work. We act with honesty, integrity, transparency, and environmental responsibility in all of our joint endeavors.

**Learning through partnerships.** We work efficiently and pragmatically together and with partners. Considering our diversity to be a key asset, we adapt readily to change and strive to improve our performance through continuous learning.

**Innovation for impact.** We develop innovative solutions to important challenges in tropical agriculture, resulting in major benefits for the people who support, participate in, and profit from our work.

**CIAT’s role in CGIAR research**

In 2011, the CGIAR Consortium formulated its Strategy and Results Framework, which defines four broad outcomes: reduced rural poverty; stronger food security; improved nutrition and health; and sustainable management of natural resources. The framework sought to establish a food-secure future in the wake of the global food price crisis in 2007–2008, which caused tremendous hardship for poor consumers across the tropics.

Today, a set of global goals are under development to replace the United Nations Millennium Development Goals (MDGs) for hunger and poverty reduction, which expire in 2015. The new goals are likely to reflect the various dimensions of sustainable development – economic growth, social inclusion, and environmental protection – as articulated at Rio+20. Those dimensions along with a fourth – good governance – will most likely be prominent in the new goals, to be known as Sustainable Development Goals (SDGs). Agriculture and food systems will be central to the post-2015 agenda, not only for ending hunger but also for coping with climate change and environmental degradation.

CIAT’s new strategy was developed to support CGIAR’s Strategy and Results Framework (SRF) and the priorities likely to be set by the SDGs (Figure 6). Our research is tightly aligned with CGIAR’s current portfolio of global research programs. Indeed, CIAT participates in many of these programs, making us a key contributor to CGIAR’s research agenda. The breadth of our research and regional presence will ensure the continued relevance of our work to CGIAR’s SRF.
In addition to CIAT’s significant contribution to CGIAR’s current research agenda, our strategy proposes a number of strategic initiatives, inspired by new global challenges, scientific breakthroughs, and out-of-the-box thinking. Through these initiatives, we expect to produce exciting innovations that have the potential to strongly influence future directions in CGIAR research.

**Figure 6.** CIAT’s strategic contribution to global research for development

### CIAT’s research strengths

Our mission – to reduce hunger and poverty, and improve human nutrition in the tropics through research aimed at increasing the eco-efficiency of agriculture – has led us to develop a broad assortment of research strengths. These are arrayed across three research areas, as indicated with selected examples below.

**Agrobiodiversity**

- Plant genetic resources: *In vitro* and seed conservation
- Beans: Breeding for tolerance to physical stress and enhanced nutritional quality; national research alliance in Africa
- Cassava: Breeding for added-value traits and enhanced nutritional quality
- Tropical forages: *Brachiaria* breeding and diverse climate-smart options
- Rice: Hybrid development; breeding for enhanced nutritional quality; research consortium in Latin America and the Caribbean

**Soils**

- Sustainable intensification: Diagnosing soil constraints and yield gaps, and targeting interventions to enhance soil fertility and increase soil and water productivity
- Land restoration: Assessing and monitoring landscapes and developing pathways towards greater resilience
• Climate change adaptation and mitigation: Using soil and land information to develop site-specific solutions and metrics for climate-smart agriculture

**Decision and policy analysis**

• Climate change: Analyzing impacts, developing adaptation and mitigation strategies, and evaluating policies
• Ecosystem services: Evaluating benefit-sharing mechanisms for smallholder farmers in key catchments
• Linking farmers to markets: Development of sustainable commercial relationships and inclusive supply-chain policies

Research in these areas has yielded an impressive record of achievement over the past 45 years. Yet, the areas have sometimes been more independent of one another than is desirable for a center that needs to address many complex issues. In pursuing this strategy, we intend to integrate activities more closely between our three research areas, building on CIAT’s substantial experience in working on diverse farming systems.

Our integrated research on farming systems will benefit from the use of simulation modeling tools to explore new options. This research will also require a strong social science component to determine the viability of different options beyond purely biophysical considerations.

Efforts to integrate the work of our research areas will involve active coordination of our activities in sub-Saharan Africa, Asia, and Latin America and the Caribbean. We are certain that our close involvement in many CGIAR research programs – which integrate the work of CGIAR centers and partners – will contribute to better integration of CIAT’s work as well.

CIAT’s research strengths are not absolute but evolve over time to meet changing needs and developments in science. Our work on crops, for example, will increasingly require the use of genome selection tools and high-throughput phenotyping and genotyping. Our soil scientists will build more capacity to devise strategies and incentive schemes aimed at reversing land degradation. Policy analysis and engagement will increase, with the aim of ensuring that breakthroughs in upstream science translate into large-scale impacts in our focus regions.

**CIAT’s growing strength in data analysis**

Our research strengths in diverse areas have given rise to a formidable capacity in CIAT for data collection, processing, management, and analysis, including an ability to integrate different types of data (quantitative, descriptive, and digital) across agricultural disciplines. This capacity is critical for achieving and documenting development impact (see box on page 18). New science and technology will give data analysis an even more prominent role in CIAT’s future research.
To this end, the Center will strengthen its focus on “big data,” seeking to achieve major improvements in the way our scientists collect, analyze, manage, improve, and share the right kind of data for decision-making. Building on past successes with data sets on genetic resources and the global environment, for example, Center researchers will devise intelligent monitoring systems for the crops we research (focusing on pest and disease dynamics and variety adoption) and create a system to support site-specific crop management, which is responsive to climate, soils, and local socio-economic conditions.

**Cultivating an impact culture**

The analysis of data on outcomes and impact is essential for enabling CIAT to make appropriate decisions about our research focus and funding priorities, and for influencing donors’ investment decisions. The Center’s impact assessment experts monitor and document our research outcomes in target regions and conduct and publish ex-post impact and foresight studies. Moreover, they raise awareness among CIAT staff and partners about the importance of analyzing and documenting outputs, outcomes, and impacts, with the aim of cultivating an impact culture.

**Infrastructure renewal**

No research organization can maintain its critical strengths for long without ongoing improvement in equipment and facilities. For that reason, CIAT will seek to develop world-class green infrastructure and acquire innovative technologies, with the aim of keeping our Center at the frontiers of science.

Most of CIAT’s infrastructure for crop improvement, particularly supporting facilities such as growth chambers and greenhouses, was designed and built in the 1970s. This aging infrastructure is expensive to maintain and difficult to adapt to new services and technologies, which are needed to fulfill our goal of making agriculture more eco-efficient. CIAT’s infrastructure should foster cutting-edge science and bring greater innovative capacity to research programs.

Our plans for infrastructure development involve the following:

- High-quality research facilities that increase our capacity to deliver development impact
- Automation and high-throughput technology to increase research efficiency
- Greenhouses, screenhouses, and irrigation systems that demonstrate innovations for partners in the public and private sectors

By providing access to specialized equipment in state-of-the-art laboratories, CIAT will better enable its partners to engage in rigorous research. Enhanced infrastructure can thus serve as a shared platform for national research programs, universities, and other regional initiatives, adding value to our collaboration through capacity strengthening programs.
Chapter 3

CIAT’s future research directions

CIAT will address the development challenges described in Chapter 1 through a research agenda shaped by several factors. These include our eco-efficiency vision, our commitment to supporting CGIAR research programs, and our well-established strengths in research and partnership. On that basis, we have defined three strategic objectives – which are central for achieving upward spirals of growth – as well as an expected outcome for each.

1. Make affordable, high-quality food readily available to the rural and urban poor by boosting agricultural productivity and enhancing the nutritional quality of staple crops.

   Improved crop varieties and practices resulting from CIAT research will enhance the food security and income potential of at least 10 million rural households while providing more affordable and nutritious food for at least 15 million households.

2. Promote rural income growth by making smallholder agriculture more competitive and market oriented through improvements in agricultural value chains.

   As a result of CIAT’s work, at least 3 million smallholder farmers will gain additional entrepreneurial capacities thus improving their access to current agricultural markets and helping them seize new opportunities to enter growth markets.

3. Provide the means to make a more intensive and competitive agriculture both environmentally sustainable and climate smart.

   In the areas where CIAT works, our efforts will reduce the rate of expansion of the agricultural frontier and enable at least 1 million farmers to gain access to environmentally friendly technologies. Agriculture emissions will be reduced, and climate-smart policies will be established in at least 10 target countries.
This chapter describes the research that CIAT will conduct in pursuit of our strategic objectives. This research, it should be underlined, contributes materially to the CGIAR’s research agenda. Indeed, as has been noted, CIAT participates in many CGIAR research programs, covering work on crops and livestock, natural resources, major agricultural systems, and key development themes.

The research described here reflects the shared conviction of CGIAR and CIAT that agriculture in the tropics and subtropics must undergo significant change on many fronts – including the crop varieties that farmers grow, the markets in which they participate, the production systems they manage, the agricultural landscapes they inhabit, and the policies that influence their options and decisions. In addition to the diverse lines of research described in this chapter, CIAT will assign high priority to various cross-cutting areas: partnerships, gender, capacity building, knowledge management, and institutional culture. Our plans for work in these areas are described at length in Chapter 5 of this strategy.

**Crop improvement**

In the years ahead, CIAT foresees a steady demand for crop varieties that give higher and more stable yields, despite pervasive soil degradation, climate change impacts, and the rising cost of key inputs like fertilizer and water. To keep pace with this demand, we will focus much of our research on developing new varieties that are high yielding, adapted to a variety of environments, and resilient in the face of multiple stresses.

In keeping with CIAT’s eco-efficiency principle, our research will seek to enhance the physiological and agronomic efficiency of crops, resulting in higher yields per unit of input, particularly in areas where soil fertility is low. Since eco-efficiency often translates into a more climate-smart agriculture, CIAT will orient its crop research to areas where climate change adaptation and mitigation are high priorities.

One of the most effective ways to make crop production more eco-efficient is to achieve yield stability and reduce the chances of crop failure in the face of diseases and pests, whose dynamics are shifting as a result of climate change. To this end, CIAT research will focus both on host plant resistance and biological control.

Recent advances in gene discovery and genomics-based precision breeding have opened up exciting new opportunities for increasing the speed and reach of genetic improvement. CIAT scientists are already using marker-assisted or genome-wide selection. We have also begun developing tools and technologies that can facilitate crop improvement by revealing the molecular genetic basis of cassava, common beans, rice, and tropical
forages and by creating a better understanding of the genetic
and physiological basis of important agronomic traits.

We will seek to accelerate crop improvement by using methods
and technologies that make it possible to handle larger volumes
of genetic material and to select with greater precision. This
will involve stronger integration of conventional plant breeding
approaches with tools and methods from biotechnology,
including molecular markers, tissue culture, genomics,
phenomics, and related fields.

While each of CIAT’s focus crops will require a specific approach,
all will involve finding better means to access, understand, and
use genetic diversity, such as:

• Elucidating and exploiting the biological basis for productivity
gains
• Reducing the breeding cycle (e.g., from 6 to 3 years in the
case of rice)
• High-throughput phenotyping, especially with the use of
remote sensing and metabolomics
• “Shuttle breeding” to exploit the complementary
characteristics of different selection sites
• Applying molecular marker-assisted selection for traits
controlled by major genes
• Using genomic selection for a wide range of traits
• Exploiting genomics and bioinformatics tools
• Improving data management to optimize breeding efficiency

As CIAT’s plant breeding teams implement novel strategies to
accelerate crop improvement, they will make digital genetic
information an integral part of this work, enabling us to provide
not only improved germplasm to our partners, but also a wealth
of information in the form of allelic DNA sequences.
Safeguarding and using crop genetic resources

Crop genetic resources are vital for developing new crop varieties that meet the requirements of eco-efficient agriculture. Wild species related to crops are particularly important for enabling crops to cope with climate change, as these plants often contain genes for traits needed to enhance resilience.

CIAT’s genebank maintains the world’s largest collections of beans (nearly 36,000 samples) and cassava (nearly 7,000 samples) along with their wild relatives as well as tropical forages for livestock (over 23,000 samples). CIAT participates in the wider effort to safeguard CGIAR-held collections and to make their diversity available to breeders and researchers under the terms of the International Treaty on Plant Genetic Resources for Food and Agriculture. CIAT has deposited nearly 31,000 duplicate samples of seeds from its collections in the Svalbard Global Seed Vault as a safety backup.

In the coming years, CIAT proposes to create a new genebank that will take advantage of the latest gene-sequencing technologies to assess genetic diversity more fully, while also managing germplasm (as seed and in vitro plantlets) more efficiently. The new facility will be able to distribute both physical seeds from the CIAT collections as well as the related digital genetic information that is vital for unlocking their hidden genetic potential. In addition, it will serve as a focal point for strengthening national capacities and creating stronger public awareness of the value of plant genetic resources.

Enhancing crop nutritional quality

Crop quality is another key dimension of eco-efficiency that offers huge potential for genetic improvement. Increasing micronutrient content, for example, using an approach referred to as crop biofortification, has shown great promise for helping overcome malnutrition. As part of its contribution to CGIAR research, CIAT will seek to develop and scale up biofortified bean and cassava varieties that are agronomically competitive and more nutritious than varieties currently grown.

In target countries, the deployment of biofortified varieties will engage both the public and private sectors through integration with national nutritional and agriculture investment plans. The deployment of varieties will be strengthened by building capacity in international centers and national programs to mainstream and measure nutritional breeding. At CIAT, this research will also address marketing dimensions across the value chain to minimize market failures and other bottlenecks, and promote food diversification through interventions based on a food basket approach.
**Crop Focus**

CIAT will continue to concentrate on the vital four crops described below.

**Common bean**

Decades of CIAT research on beans – the world’s most important food legume – have led to massive uptake of high-yielding varieties, with significant impacts on food security in major bean-producing countries, such as Ethiopia, Rwanda, and Uganda. The challenge now is to raise rural incomes by facilitating smallholder access to markets, while stabilizing yields through the development of stress-tolerant bean varieties and enhancing human nutrition with biofortified beans. In Africa, where common bean is mostly grown by women, we will ensure that they derive significant benefits from our efforts to improve bean productivity and markets.

**Outcome targets for enhanced nutritional quality**

By 2018, 6 million people in Rwanda, 2.5 million in the Democratic Republic of the Congo, and 5 million in five countries of Southern Africa (Mozambique, Zambia, Zimbabwe, Malawi, and Swaziland) will be consuming high-iron beans, and 50% of the bean seed marketed in these countries will be biofortified.

**Bean production at a glance**

- In 2011, the global production of dry beans stood at 23 million tons, with Latin America and the Caribbean accounting for 28% and Africa 17%.
- Over the past decade, Africa’s bean production has increased at an annual rate of about 4%, principally through the expansion of the area planted, with yields rising by just 0.7% annually. In contrast, Latin America’s bean area declined, especially in Brazil, while yields rose by 1.8% annually.
Cassava

Cassava is the third most important food crop in the tropics, after rice and maize. In Southeast Asia, where CIAT focuses strongly on this crop, cassava serves as a source of food and livestock feed, while also providing raw material for the manufacturing of pharmaceuticals, industrial starch, biofuels, and other products.

Over the past several decades, CIAT’s research has led to significant increases in cassava production and productivity, largely through widespread adoption of improved varieties but also due to improvements in crop husbandry and market linkages. Average cassava yields have doubled since CIAT started working in the region.

As a result, cassava is important not only for rural households but for national economies. Southeast Asia’s cassava industry generates billions of dollars a year and exports well over three-quarters of the world’s internationally traded cassava, with more than half going to China. To help maintain the momentum of the region’s cassava boom, over the next decade, CIAT scientists will work with partners to boost yields by at least another 30% through continued genetic improvement and better agronomy as well as pest and disease management.

Cassava production at a glance

- Since 2001, global cassava production has increased at an annual rate of 3.4% – reaching 256 million tons in 2011.
- In Asia, which accounted for one third of global cassava output during this period, production grew at a higher annual rate (5%) than in Africa (3.5%), which contributed more than half of global production. Asia’s increases in cassava production resulted more from yield improvement (which grew at an annual rate of 3.1%) than from expansion of the area planted (1.8%).
- Strong demand for cassava as an industrial raw material in Asia has been the main driver of technology adoption and resulting yield gains. International cassava trade climbed at an average yearly rate of 4.8%, principally as a result of growing exports within Asia.
Tropical forages
In Southeast Asia and other regions where CIAT works on tropical forages, livestock have served the poor as a social safety net, providing insurance or a “bank account” for times of need and crisis. But increasingly, more intensive livestock production provides regular income for improved livelihoods. Easy access to high-quality forages for animals has proved to be a crucial entry point for improving production, management, and animal health.

Improved forages enable farmers to save labor and raise incomes by boosting the market value of their livestock. While better livestock feeding systems have been adopted quite widely, further expansion will require promotion of new practices across the wide range of ecologies and farming systems in the region.

In Latin America, high-quality Brachiaria grasses, many of them improved at CIAT, have been widely adopted and cover an area estimated at over 25 million hectares, generating large economic benefits. Recent work on tropical forages in Africa has demonstrated how superior grasses can help relieve the continent’s severe shortage of feed resources and thus add momentum to its livestock revolution, which is critical for diversifying diets and raising rural incomes.

Rice
During the 1960s and 1970s, the rapid spread of new semi-dwarf rice varieties in Latin America and the Caribbean (LAC) boosted production tremendously. Since then, while rice yields have risen slowly, researchers have still registered important efficiency gains by developing new generations of improved rice that are well suited to the region’s rice-growing environments and practices. In recent years, they have also developed varieties that promise to deliver significantly higher yields. These advances in rice improvement and resource use are underpinned by significant institutional innovations, particularly the creation of a successful regional rice consortium that unites public and private sector organizations with farmer associations.

Rice production in LAC at a glance
- Rice continues to be an important staple food in Latin America and the Caribbean, though the region accounts for only a minor share of global production. Over the last decade, rice production in this region grew at an annual rate of 2.3% – reaching 29–30 million tons in 2011 – mainly as a result of yield gains.

1 While data on the adoption of tropical forages are available, detailed information on trends in the production and use of these resources for livestock feeding is limited.
Sustainable intensification of agriculture

While raising crop yield potential, CIAT will foster the development of improved crop and soil management practices that permit optimal expression of genetic potential. This work will form part of our larger global effort to achieve sustainable intensification of agriculture in the tropics and subtropics, based on the concept of soil health. Maintaining or restoring soil health is a matter of managing soil biology appropriately, making good choices about soil cover and crops, maintaining balanced nutrient supplies, and maximizing organic amendments.

Improving agricultural productivity requires more efficient use of nutrients and water. To this end, CIAT soil scientists will promote the use of cost-effective diagnostics to gain a better understanding of soil variability and thus provide a basis for adapting soil management to specific conditions. This work will build on our long history of generating soil data and information on smallholder production systems in the tropics.

In the years to come, our researchers will expand current efforts – involving approaches such as integrated soil fertility management and conservation agriculture – to open new pathways toward sustainable intensification, which take into account different economic and environmental contexts.

Outcome targets for better soil and land management

CIAT’s contribution to CGIAR research will help leverage an investment of more than US$100 million in sustainable intensification of agriculture. The implementation of policies for landscape management will be strengthened in target countries, and more than 100,000 women will be involved in improved decision-making on natural resource management, contributing to a nearly 50% reduction in the rate of soil and land degradation over 100,000 square kilometers.

Restoring degraded land

In many parts of the tropics and subtropics, achieving sustainable increases in agricultural productivity will require a significant investment in sustainable land management. This is an integrated, participatory approach to the use of land resources for agricultural production. It is essential for ensuring the long-term productivity of these resources and for maintaining their environmental functions, while improving livelihoods through stronger food security and higher incomes.

Recent years have seen a growing demand for more concerted efforts to achieve land degradation neutrality. This was a key message of Rio+20, and it will no doubt come out in the new
Sustainable Development Goals. Several major development agencies have taken up the call for building up agriculture’s natural resource base to enhance the resilience of farming communities.

CIAT has built a unique combination of innovative capacities and partnerships for monitoring land quality and ecosystem services (including assessment of progress in land restoration), analyzing the tradeoffs between scenarios for change, measuring gender impacts, and identifying the economic and social incentives required for change. On this basis, CIAT scientists will contribute significantly to sustainable land management by improving the quality and quantity of soil information available to national partners, by mapping soil functional properties (such as soil organic carbon), and by evaluating ecosystem health on a landscape scale. Achieving impact through this work will require intensive engagement with land management planners and investors.

**Enhancing ecosystem services**

CIAT’s global efforts to reverse land degradation are linked to important work aimed at protecting critical ecosystem services, which include the provision of water and food supplies, maintenance of soil fertility, biodiversity conservation, and climate change mitigation.

The Center’s current work on ecosystem services entails the development of tools and methodologies to quantify, map, and value ecosystem services in landscapes and watersheds. We also value ecosystem services for a variety of stakeholders to inform the negotiation of benefit-sharing mechanisms and determine the level of investment and incentives required to protect ecosystem services. In addition, we analyze the environmental impacts of introducing new land use alternatives in agricultural areas, determine the socio-economic consequences of introducing payment for ecosystem services schemes, and provide recommendations on the most appropriate means to distribute the benefits and costs of improving ecosystem services more equitably.

To enhance the impact of this work, CIAT will work with decision- and policy-makers to connect research with institutional mechanisms for protecting ecosystem services, such as benefit sharing, fiscal incentives, and land management policies. For this purpose, we will conduct case studies with government ministries, research organizations, farmers associations, and other stakeholders in our research in Latin America and sub-Saharan Africa. These studies will deal with the impact of alternative land uses on ecosystem services and with institutional strategies for recognizing the value of these services. A key product of this work will consist of pro-poor
recommendations on the most effective means to distribute the benefits and costs of ecosystem services more equitably.

Our research will also examine the impact of plausible climate change scenarios on the provision of water-related ecosystem services in watersheds. In addition, through the strategic initiative presented in Chapter 4, we will seek to better understand how ecosystem services contribute to food and nutrition security in impoverished rural areas and identify – through social and cultural analyses – other implications of these services for the well-being of rural people.

**Outcome targets for enhancing ecosystem services**

Ecosystem services will be enhanced in dozens of agricultural landscapes, including improved soil quality on about 1.2 million hectares, with benefits for 1.8 million rural people.

### Linking farmers to markets

If efforts to intensify agriculture sustainably while restoring degraded land and enhancing ecosystem services are to succeed, they must enable rural men and women to gain a larger share of the benefits from economic modernization and globalization. Often, these benefits do not translate into higher incomes for the rural poor, because the rapid modernization of domestic markets for agricultural produce is highly uneven, and well-financed large-scale suppliers increasingly capture markets for higher value export products. Overcoming such obstacles is critical for realizing the enormous potential of smallholder agriculture as an engine of inclusive economic growth.

In connection with CGIAR research, CIAT will identify key leverage points that permit sustained and beneficial commercial relations between farmers or their organizations and buyers in diverse market contexts. We will conduct research on policies that foster an enabling environment for linking farmers to markets. In collaboration with key actors in the public and private sectors, CIAT researchers will develop methods, tools, and guidelines for promoting and evaluating commercial relationships, and they will conduct quantitative and qualitative evaluations of the different impacts and outcomes of these approaches on the livelihoods of rural women and men.

Through the strategic initiative described in Chapter 4, CIAT will adapt and apply such methods and tools for the purpose of enhancing the influence of urban consumers in markets, with emphasis on the health and environmental aspects of food consumption. Advanced information and communications tools will be used to significantly expand our knowledge of how value chains actually work and how we can make them more efficient.
We will also seek better ways to realize the market potential of the crops for which we conduct genetic improvement. By creating unique starch qualities in cassava, for example, we will enhance its value for a variety of agro-industrial purposes, thus offering new income-earning opportunities to smallholder cassava producers, especially in Southeast Asia and in some African countries, particularly Nigeria.

Similarly, improved tropical forages, by enhancing animal nutrition, will help turn subsistence livestock rearing into sustainable and market-oriented smallholder production of milk and meat. The scope for achieving such a transformation is especially great in Eastern and Southern Africa, Central America, and Asia. Apart from the immediate livelihood benefits, new market opportunities will offer farmers compelling incentives to adopt yield-enhancing technologies that help close yield gaps.

**Outcome targets for linking farmers to markets**

- Up to 675,000 rural households will increase and diversify their incomes, for the benefit of all household members, as a result of improved capacity in farmers organizations to engage in beneficial commercial relationships.
- Smallholder cassava producers occupying at least half of the more than 2 million hectares on which this crop is grown in the Greater Mekong Subregion will benefit from stronger links with the cassava-processing industry.
- Adoption of new high-yielding bean varieties with strong market appeal will strengthen the food security and raise the incomes of 3 million rural households (or about 15 million people) in sub-Saharan Africa and Latin America.
- Within the next decade, at least half a million farmers in Southeast Asia and Latin America will start sowing improved pastures on an additional 3 million hectares, increasing milk and meat productivity by 20%.

**Toward climate-smart agriculture**

Climate change poses a formidable challenge for agriculture and the global food system as a whole. In response, CIAT has undertaken a major effort to develop and implement novel methods for generating information that can guide policies and decisions related to climate change adaptation in tropical agriculture.

Conducted in support of the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), which CIAT leads, this work includes *ex ante* assessment of the likely impacts of climate change on agricultural productivity, ecosystem services, and rural livelihoods. CIAT scientists also
conduct socio-economic and environmental evaluations of technological options and policy instruments, with the aim of informing the development of national and sectoral adaptation and mitigation plans.

With local partners in Latin America, Africa, and Asia, CIAT will develop and implement mechanisms for enabling farmers to manage agricultural risks, including weather index-based insurance schemes and climate forecasting. To promote large-scale adoption of climate-smart agricultural practices and technologies in target regions, CIAT will identify, prioritize, and test such practices and gain a better understanding of the conditions needed to accelerate their adoption.

To support this work, the Center has embarked on a significant effort to foster climate change adaptation and mitigation through improved soil management, a previously neglected dimension of the challenge. Our efforts will focus on sharing information about soil functional properties, such as water-holding capacity and organic carbon content, which is essential for assessing climate change impacts meaningfully and for understanding where and how adaptation strategies can succeed. CIAT can help overcome barriers to the use of such information through new capacities developed in recent years to provide high-quality soil data rapidly and at low cost.

Much of CIAT’s crop research will also help address the challenge of climate change – through, for example, the improvement of drought tolerance in beans and rice and the development and promotion of *Brachiaria* grasses, which show huge mitigation potential.

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**Outcome targets for climate-smart agriculture**

CIAT’s contribution to CGIAR research will help increase emissions efficiency in tropical agriculture by 15% in 10 countries that possess high mitigation potential. The governments of these 10 countries will develop climate-smart policies, with the aid of Center research, leveraging an investment of at least US$50 million in programs to improve agriculture.

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2 Emissions efficiency refers to carbon dioxide equivalent emissions per unit of product (e.g., ton of grain, kilogram of meat, or liter of milk). For the growing agricultural sectors of many developing countries, this offers a more appropriate measure of mitigation efforts than do net values for total emissions. Increasing the stocking rate of cattle per hectare, for example, implies increased emissions per hectare but vast improvements in emissions efficiency per unit of product.
Chapter 4

Strategic initiatives: New pathways to impact

Over the next few years, CIAT will launch a set of forward-looking strategic initiatives, which are designed to boost the development impact of our work through an integrated approach that draws on all three of CIAT’s research areas.

Our new initiatives will respond to emerging research issues and build on new developments in science. Some of them will closely complement the Center’s contributions to CGIAR research programs. Others will address, on a pilot basis, emerging issues that are currently outside the scope of those programs, creating insights and approaches that could significantly influence future CGIAR research. The proposed strategic initiatives are described briefly below.

Tropical forages for eco-efficient livestock production

In recent decades, a livestock revolution has gained momentum in many developing countries. Driven by population increases and rising urban incomes, the consumption of livestock products has tripled since the 1970s and is set to double again by 2050. Livestock productivity can be boosted by increasing the quantity and quality of feed, improving animal health practices, and using targeted breeding strategies. The challenge is to sustain the livestock revolution – thus providing more food for consumers and income for farmers – without destroying natural resources and raising greenhouse gas emissions in the process.

Livestock production systems dominate agriculture in the developing world, providing livelihoods for about 1 billion people. Unfortunately, they may also have a negative impact on the environment. Livestock systems are estimated to contribute about 50% of all greenhouse gas emissions from the agricultural sector. Much of the world’s pastureland has already been degraded by grazing or feed production, and many forests have been clear-cut to make way for additional farmland. The production of grain-based feed requires intensive use of water, fertilizer, pesticides, and fossil fuels.

There is ample evidence that improved tropical forage-based systems have the potential to reduce greenhouse gas emissions and to sequester substantial amounts of carbon in soils. CIAT has reported that high-quality forages, such as *Brachiaria*, are second only to native forest in terms of their potential for storing soil carbon. In areas with high rainfall, they could even sequester more atmospheric CO₂ than forests.
Some *Brachiaria* species also reduce levels of the most potent greenhouse gas emitted from farming systems – nitrous oxide – through a mechanism in their roots that limits nitrogen loss from the soil. More nitrogen in the soil means farmers need to apply less nitrogen fertilizer. *Brachiaria* has been shown to produce higher milk and meat yields in cattle – 10 times more per unit land area than if the animals grazed on native savanna grass. And because it is a high-quality, easily digestible food, animals fed with *Brachiaria* emit less methane per kilo of meat produced.

CIAT believes that a new approach – which we refer to as “LivestockPlus” – centering on forage-based production systems can contribute significantly to climate change mitigation, while also delivering additional benefits, such as improved livelihoods, erosion control, soil improvement, and the restoration of degraded lands. Improved livestock feeding practices in Brazil, backed by strong tax incentives, have already resulted in significant reduction of greenhouse gas emissions. Similar concepts are being explored in Colombia.

In the coming years, CIAT will identify approaches to sustainable intensification that realize the livelihood and environmental benefits of forage-based systems on a large scale. We will study the current and potential climate change impacts of various livestock production systems in the tropics and define strategies for large-scale intensification of livestock production systems that are more climate friendly, more efficient in using resources, and more economically and ecologically sustainable.

**Sustainable food systems for a rapidly urbanizing world**

More than half of the world’s population lives in urban areas and, by 2050, this figure will have risen to 67%, on average. Rapid urbanization is driving profound shifts in global diets, which in turn have important social, economic, political, health, and environmental implications. The major changes include reduced intake of starchy crops, increased consumption of livestock products, more frequent eating outside of the home, reduced food awareness, and greater consumption of processed products.

Those and related trends are increasing the triple burden of under-nutrition, malnutrition, and over-nutrition in developing countries, while also contributing to food waste (Figure 7). More than a third of the food produced globally is lost\(^3\) or wasted, and the problem is increasing. While in industrialized countries food waste may be as high as 40–50% and is concentrated mostly near the consumer end of the food chain, the figure is 20–30% for

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\(^3\) Food loss refers to the decrease in edible food mass at the production, post-harvest, and processing stages of the food chain, mostly in developing countries. Food waste, a symptom of consumption lifestyles, refers to discarded food at the retail and consumer levels.
the less developed countries, where losses typically occur near the production and distribution end. Food waste represents an important missed opportunity to strengthen food security at a lower environmental price.

Figure 7. Per capita food losses and waste, by region

To put rapidly changing food systems on a sustainable development path is an enormous challenge, requiring simultaneous interventions along entire food chains – from production and processing to distribution and consumption. Recent research identified five interlinked transformations in food systems, which are needed to satisfy demand. These relate to urbanization; diet; food markets; rural factor markets; and agricultural technology and land size. This research also emphasizes the need to pay greater attention to rural-urban supply chains, especially their post-farmgate segments.

Yet, there is a lack of information about the new dynamics and challenges of rural-urban supply chains. Until now, CGIAR research has been almost entirely concerned with rural production systems. CIAT and CGIAR research must gain a better grasp of the functioning of whole food systems if we are to succeed in strengthening food security.

As a first step in addressing these challenges, CIAT proposes to expand our successful agenda of research on linking farmers to markets, so that it addresses (1) the continuum from markets to final consumers and (2) the performance of entire value chains, including processing and distribution. At the same time, our ongoing research on consumer preferences with respect to biofortified crops will be significantly expanded to enable us to better understand food needs and shifting demands. We will also address food quality attributes and food safety issues. The results of this research should enhance the impact of CIAT’s crop improvement strategies and allow us to tackle food security challenges more holistically through effective efforts to address access, distribution, and nutrition.
Research on entire value chains will focus on optimizing chain efficiency; reducing food waste and crop losses; and seizing opportunities for value addition in urban-rural nutrient flows. This implies additional research on chain actor organization and integration, among other issues. Building on CIAT’s past experience in post-harvest research, new efforts will attempt to reduce food waste from the supply side. Alternative gene-based technologies, including the development of crops with a longer shelf life, can also help reduce losses at different stages in the food chain. Future research on nutrient flows and metabolism will start with life cycle assessments, with which CIAT has some experience related to cassava in Southeast Asia.

The expected outcomes of this research include crops with higher nutrient content and other functional properties that are more appropriate for specific consumer groups as well as a better understanding of how food security can be achieved through a supply chain approach, focusing primarily on supply chains for the crops on which CIAT works. This should translate into reduced food losses and greenhouse gas emissions, improved biomass recycling, and lower prices for more accessible, better quality food in urban areas. These changes will have significant socio-economic and environmental impacts at the global level, especially in urban areas, where the majority of the poor live.

Reducing food waste by 30% at the point of consumption in developed countries could save an estimated 40 million hectares of cropped land as well as enormous amounts of water and fertilizer. For the hundreds of millions of smallholder farmers who are substantially self-sufficient in food and market their surpluses, reducing food losses will mean substantial increases in consumption and income, with significant improvements in health.

Reducing yield gaps for sustainable intensification of agriculture

A yield gap is the difference between observed crop yields and those attainable in a given region. Yields of the major crops grown in developing countries are often far below their economically feasible and ecologically sound potential. Enabling farmers to narrow these gaps and stabilize yields in a sustainable manner is a major requirement for achieving long-term global food security.

Yet the challenge is far from straightforward (Figure 8). A great deal of progress has been made recently in developing better methodologies for analyzing yield gaps, mapping these gaps for major crops at the global and regional scales, and studying the diverse contexts. But much remains to be done before we can gain a sufficient understanding of yield gaps and instability in smallholder agriculture to permit the application of this knowledge on a large scale through concrete actions in farmers’ fields.
As crop modelers and agronomists struggle to quantify the yield potential of a given crop in a particular place, the yields that are biophysically or genetically possible often do not correlate well with the achievable potential in a given agro-ecosystem and socio-economic context. As a result, striving to increase yields to the economic optimum may come into conflict with the target of optimizing resource use efficiency. A further complication is that the yields farmers actually obtain vary greatly over time and space, and reliable, long-term yield data are scarce.

Any plan aimed at reducing yield gaps must begin by gaining a more precise understanding, not just of their size and geographical distribution, but also of the underlying biophysical and socio-economic causes for these gaps at the subnational and local levels. CIAT is well placed to address this multidisciplinary challenge in the tropics and subtropics. Our ample expertise in agronomy; crop modeling; integrated pest and disease management; and the assessment, mapping, and management of soil fertility gives us a strong comparative advantage to assess yield gaps, and identify opportunities for improved nutrient- and water-use efficiency in major crops, including maize, beans, cassava, and rice.

Moving this strategic initiative forward will involve two main steps. The first is to define at high spatial resolution the quantitative importance of biophysical constraints, including water or rainfall, soil nutrients and fertility, and pest and disease incidence. CIAT research can take the assessment a step further by also singling out the influence of poor market access, knowledge gaps, conflicting policies, gender disparities, and institutional arrangements. The second step involves the development of management recommendations for reducing yield gaps.

In collaboration with its national partners, CIAT will identify regions in sub-Saharan Africa where notable yield gaps exist and there are compelling possibilities to close these gaps. Our research will focus initially on maize and common bean, two of
the region’s most important crops. CIAT researchers already have in-depth knowledge about the performance and agronomy of these crops.

We will pursue a similar approach with cassava in Asia and major farming systems in Latin America, building on our successful experience with reducing yield gaps in rice production. This research will rely on the comprehensive soil fertility database and maps that CIAT has developed in recent years and will also draw on our strengths in socio-economic, gender, and market research. In this way, we can establish common metrics and disentangle the biophysical and social causes of low yields, while helping to target strategies that address the limitations of smallholder agriculture.

In the target regions, scientists from all three of CIAT’s research areas will work together to analyze information about the current and attainable productivity of key commodities and about their association with climatic, socio-economic, and biophysical conditions (including soil and landscape variables), leading to the development of site-specific interventions through “big data” approaches that bring the digital revolution to agriculture. Our research will also seek to strengthen farmers’ links to markets, with the aim of offering farmers stronger incentives to reduce yield gaps.

**Realizing the value of ecosystem services for human well-being**

A new paradigm for agricultural development is emerging, in which healthy ecosystems are seen as a prerequisite for more resilient food systems and enhanced human well-being. CIAT will expand current work on ecosystem services to better realize their huge potential for improving livelihoods.

According to a recent estimate, ecosystem services account for 47–89% of the so-called “GDP of the poor,” i.e., the total livelihood resources available to poor households living in rural areas and forests. The interactions between ecosystem services and human well-being in specific locations are not usually well understood or taken into account. This is particularly true in mixed farming landscapes, where the services, social and cultural landscape, and relationships between them are complex. Understanding these complex relationships is essential for managing tradeoffs and ensuring that the poor are able to benefit from efforts to achieve sustainable intensification of agriculture.

New CIAT research will explore how efforts to enhance ecosystem services in agricultural landscapes, including food production, can improve the well-being and adaptive capacity of rural communities. This work will complement other CIAT research aimed at reducing poverty (such as our efforts to boost crop yields and rural incomes) by highlighting the opportunities for the
rural poor that can result from better maintenance of ecosystem services. To realize these opportunities requires more integrated research, which fully incorporates the human dimensions of ecosystem services.

In specific landscapes, this research will determine the links between ecosystem services and people’s livelihoods and identify opportunities for local people to benefit – for example, through the consumption of edible wild species that grow in farmers’ fields and show high nutritional value, the sale of promising non-marketed goods, and the design of benefit-sharing mechanisms, such as payment for ecosystem services.

To ensure that our research on ecosystem services contributes to enhancing the well-being of the rural poor, it must incorporate gender analysis and non-monetary indicators, such as those related to food security, dietary diversity, and nutrition. The proposed research requires an interdisciplinary approach, which brings together specialists from the social sciences, agronomy, nutrition, ecology, economics, biotechnology, and other fields.

This strategic initiative will focus on mixed landscapes, where smallholder farmers lack strong market links and their livelihoods depend on ecosystem services from both undisturbed areas and agricultural systems. By putting rural people at the center of our research on ecosystem services, the initiative will ensure that CIAT’s research addresses important dimensions of rural livelihoods that are often neglected. New work will be initiated in areas of Latin America and sub-Saharan Africa where current CIAT work on ecosystem services can serve as a starting point. Our researchers will engage with a diverse array of partners, including national research organizations, universities, and civil society, including NGOs focused on conservation and social change, particularly gender equity.

Work in this area promises multiple benefits. Farmers will benefit through improved food security and more diverse income sources, derived from natural resources that are part of the farming system. Decision makers at all levels will be better informed about the opportunities that ecosystem services offer for enhancing the well-being of the rural poor – knowledge that is useful for developing food policies, conservation initiatives, and poverty alleviation strategies. Researchers will be able to measure progress in agriculture on the basis of indicators other than crop yields and agricultural income, including dietary diversity, nutrition, and livelihood resilience. They will also gain a better understanding of the tradeoffs between agricultural production and other essential ecosystem services.
Delivering the strategy: Key requirements

CIAT’s new strategy has been inspired by the huge promise of agriculture to improve the livelihoods and food security of poor people in the tropics and subtropics. We aim to deliver the strategy by building on our traditional research strengths in support of CGIAR’s research agenda and by undertaking a number of new initiatives that integrate work across our research areas and promise to move us into new and exciting areas of research for development.

Accomplishing our research and organizational goals depends on our ability to meet a number of key requirements that cut across all of our work. These include making the most of Center partnerships, ensuring that eco-efficient agriculture empowers and improves the lives of rural women, strengthening national capacities, sharing knowledge effectively, and achieving greater efficiency in all of CIAT’s operations. Having touched on most of these topics briefly in early chapters, here we give them the close attention they deserve.

Progress through partnership

CIAT aims to deliver outcomes and development impact in three regions – sub-Saharan Africa, Asia, and Latin America and the Caribbean – through a wide range of partnerships. These partnerships are essential for technology development
and dissemination as well as for fostering innovation and joint learning.

Currently, CIAT works with more than 500 partners, including national agricultural research and extension organizations, advanced research institutes, universities, international organizations, private companies, NGOs, government ministries, and farmers associations. Achieving our goals of strengthening food and nutrition security, reducing poverty, and improving environmental health will require CIAT to take on partnerships that go well beyond research.

In recent years, CIAT has given particular attention to building public-private partnerships that promise to deliver important impacts. One such partnership, for example, offers a means to create significant markets for cassava possessing novel starch traits. Another, involving a multinational seed company, is expected to result in widespread dissemination of *Brachiaria* grass hybrids in developing regions, including Africa. The Biopacific Park (see box on page 42) is another new example of a public-private partnership. In the years to come, CIAT will be open to further partnerships of this type, with the aim of opening new pathways to development impact.

The specific nature of CIAT’s partnerships varies from one region to another, according to different circumstances, needs, and opportunities for achieving eco-efficiency in agriculture.

**Delivering impact in sub-Saharan Africa**

The Comprehensive Africa Agriculture Development Programme (CAADP) provides a shared framework for the efforts of African governments to accelerate growth and eliminate poverty and hunger. CAADP defines key entry points for investment and action aimed at achieving sustainable increases in the productivity of crops, livestock, forestry, and fisheries. Many of the countries where CIAT works are committed to CAADP and have developed investment plans, which define specific research needs and priorities.

CIAT will align its support for African countries with their goals under the CAADP Investment Plans. Our scientists will work with these countries to determine the contributions that our research can make in line with their priorities and to make the implementation of their plans more effective and sustainable. While CIAT currently focuses mainly on Eastern and Southern Africa, it also conducts strategic research in Central and West Africa and will promote new efforts in South Sudan, where there is a clear need and demand for research support.

Implementing CIAT’s new strategy in line with CAADP’s goals will require us to significantly strengthen our collaboration with national partners as well as subregional organizations. One outstanding example of the latter is the Pan-Africa Bean
Research Alliance (PABRA), which CIAT facilitates. PABRA is an innovative consortium of African agricultural research organizations in 29 countries, which has achieved spectacular success since its establishment in 1996.

In addition, CIAT will apply lessons from PABRA’s experience to build new partnerships aimed at addressing the region’s serious shortage of livestock feed and widening the impact of our soils research. These partnerships will include CGIAR centers as well as national research organizations, subregional programs, NGOs, farmers associations, donors, and private companies interested in soil management, livestock feed, and forage seed.

CIAT’s work on soil management, climate-smart agriculture, and ecosystem services will also better enable governments and farmers to respond to the looming threats of land degradation and climate change. Working with national and international partners, the Center will support efforts to put current investments on a more sustainable track, providing greater long-term benefits for local populations.

Building on success in Asia
CIAT’s research in this region, concentrating particularly on the Greater Mekong Subregion and China in recent years, has created new opportunities for rural people to raise their incomes by responding to increased demand for cassava (mainly for industrial uses) and to boost livestock production through the use of improved tropical forages. In this work, partnerships with industry associations have proved critical.

CIAT and its partners are developing new initiatives in Asia that will consolidate and extend the research benefits delivered so far. For example, we are responding to the threats posed by emerging cassava pests and diseases through surveillance, biological control, and breeding for resistance. We are also seeking new ways for smallholders to engage more effectively with markets and to increase the eco-efficiency of Asia’s diverse farming systems.

Resource management is another key aspect of sustainable agriculture on which CIAT has focused its collaborative work with partners in Asia. Climate-smart food production is a critical requirement for the region. The challenges are greatest in the highly variable and marginal uplands, which are home to many of the region’s poor. Sound management of soil and water resources to sustain a more productive and market-driven agriculture is of the utmost importance.

Continued collaboration with research and development partners, including stronger research ties with Vietnam, will ensure that our future work in the region is appropriately focused and will better enable our partners to build the capacity needed to undertake research, development, extension, and
commercialization. Having achieved considerable impact in many parts of Southeast Asia, including China, we will widen the scope of our work to include Myanmar and other areas of East and South Asia.

**Multiple models for Latin America and the Caribbean**

CIAT has a long history of research collaboration in Latin America and the Caribbean (LAC). We are well known in the region for our strengths in natural resource management and the genetic improvement of beans, cassava, forages, and rice. In recent years, the Center has also built a reputation for doing valuable work on climate change, ecosystem services, linking farmers to markets, gender, and impact assessment.

CIAT is thus well positioned to support agricultural development in LAC through a wide range of partnerships. These will focus particularly on strengthening the region’s contribution to global food security, enhancing its role as a provider of environmental services, and helping diversify and boost the resilience of key farming systems. To achieve these goals will require, in addition to crop and soils research, a stronger role for CIAT in policy advocacy, aimed at addressing issues like climate change adaptation and the need for more competitive agricultural value chains under more open trade.

Our collaboration with the Colombian Corporation of Agricultural Research (Corpoica) as well as with universities and the country’s Ministry of Agriculture and Rural Development is closely linked with national priorities. We contribute mainly through crop improvement, natural resource management, and climate change mitigation and adaptation. This research aims to strengthen national food security, while also helping create new export opportunities. In the coming years, CIAT’s partnership with Colombia will serve as a model for work with other countries whose governments are giving high priority to agriculture.

The Brazilian Agricultural Research Corporation (Embrapa) is the largest national research organization in LAC. We anticipate significant new interaction with Embrapa and other advanced research institutions in Brazil, emphasizing joint research on land management, crop improvement, and production systems. Capacity strengthening also figures importantly in the partnership. In the future, new knowledge and germplasm resulting from this collaboration should benefit not just LAC but also Africa and Asia.

CIAT will also strengthen its research ties with partners in Mexico. While national research organizations in Brazil and Mexico as well as Argentina have gained considerable strength over the last 2 decades, there is a sizeable gap in technology development between them and their counterparts in most other countries of the region. CIAT will help close this gap through capacity strengthening and new partnership models.
CIAT’s LAC Bioscience Platform will contribute importantly to closing capacity gaps by supporting national efforts to develop new technologies aimed at strengthening food security and making agriculture more competitive. Relying on state-of-the-art laboratory infrastructure and human resources at CIAT headquarters, the platform will also involve an extended network of national and international institutions, such as the French research center Cirad (Agricultural Research for Development).

In Central America, CIAT will seek new opportunities to build a more integrated research portfolio, while achieving strong synergy between CIAT’s work and that of several CGIAR research programs.

In the Amazon, the Center will build new research partnerships focused on recovering degraded lands, enhancing ecosystem services, monitoring deforestation, and realizing the potential of agroforestry and livestock systems for climate change adaptation and mitigation.

Finally, we see significant opportunities for supporting agricultural development in Haiti, with emphasis on strengthening food security and building institutional and research capacity.

**Biopacific Park**

The Biopacific Park grew out of a strategic alliance between CIAT and Colombia, whose aim is to address the challenges facing our host country’s agriculture. Established in 2011, the Park serves as an incubator for competitive enterprises based on the agricultural sciences. It brings together research organizations, universities, and the private sector with the shared goal of promoting a culture of research, innovation, and public-private partnerships that make agriculture more competitive.

Together, the partners employ about 1,400 professionals, including 500 with PhDs. The research agenda for the Biopacific Park particularly concerns the need to boost the incomes of farmers in hillside areas of Colombia’s southwestern Pacific region by improving agricultural productivity.
Research on gender and agriculture

Understanding unequal social relations, especially gender relations, is vital for achieving CIAT’s objectives in agricultural research for development. These unequal relations often make women and marginalized groups more vulnerable to the effects of poverty, land degradation, and climate change. Research has shown that women often harvest less food for their efforts than do men because of the gender gap in access to land, inputs (such as improved seeds and fertilizers), and opportunities. If the gender gap were eliminated, the Food and Agriculture Organization of the United Nations (FAO) asserts that total agricultural output in developing countries would increase, thus reducing the number of hungry people.

Each CGIAR research program has developed a 4-year strategy for delivering measurable benefits to women farmers in target areas. The strategies require the integration of gender concerns into research objectives, technology development, extension strategies, and evaluation frameworks, and they involve two approaches: (1) strategic research to achieve a deeper understanding of how gender disparities or gender relations affect agricultural innovation, productivity, and sustainability; and (2) integrating gender analysis into research on topics such as plant breeding, climate change adaptation, and integrated pest management.

The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), for example, has made the need to understand and transform gender dynamics in relation to climate change one of its most important priorities. CCAFS is using lessons learned from research to plan research activities aimed at formulating adaptation and mitigation measures that are designed specifically to meet the different needs of diverse groups of women and men.

Similarly, in research on roots, tubers, and banana, CGIAR is integrating gender analysis into new and current projects, while also conducting strategic research to improve our understanding of the relationships between structural inequalities, agricultural innovations, and development outcomes. CIAT is leading gender research on the livelihood benefits of postharvest cassava processing, the implications of shifting from traditional to industrial cassava markets, and the introduction of biofortified cassava.

The Center will mainstream gender analysis across all of its three research areas, building on success stories, such as the strong gender focus of PABRA in Africa. A cross-program community of practice will ensure disciplinary excellence and strive to put CIAT in the vanguard of gender analysis in research on agriculture and...
the environment. Center researchers will generate an evidence base regarding gender issues in agricultural production and natural resource management, including men and women’s access to resources, their participation in decision-making, their knowledge and priorities, and their adoption of new technologies and practices.

Closing the gaps in research capacity

As agriculture has gained higher priority in national and international development agendas during recent years, the increased attention given to agricultural research has unsurprisingly been accompanied by a heightened awareness of the need to strengthen research and development capacity. Only if this need is adequately met, can CGIAR research make significant progress in reducing hunger and poverty, and improving the management of natural resources.

The current research capacities of emerging and developing countries around the world present a contradictory picture. Despite severe resource limitations, these countries are investing more in research for development overall. But this increase masks a growing divide between the small number of countries that are performing impressively and the large majority that are falling behind. Some countries’ scientific capacity is actually weaker than it was a couple of decades ago. To close the gaps in research capacity among countries requires a radical rethink of the tendency to assume that enhanced capacity is an automatic outcome of research.

Strengthening capacity for innovation

Much documented experience has shown that technological and other innovations are most often developed not just by researchers but also by other actors in agricultural value chains. For that reason, farmers, technicians, scientists, and other groups who contribute to rural innovation (including private firms and NGOs) all need to build new capacities, so they can co-create and adapt innovations and knowledge more effectively through collaboration and learning.

In a renewed effort to help meet the need for new and stronger capacities, CIAT will pursue two main approaches in the years to come:

- Exploring diverse options to provide the strategic training needed to implement CIAT’s future research agenda, based on clear theories of change and impact pathways
- Fostering organizational transformation in CIAT and among our partners, so that we can engage more effectively in integrated research for development
**Strategic training**

Over the past 3 decades, the declining cost of using new tools (e.g., from information technology, biotechnology, and associated sciences) has created an important opportunity to bridge technology divides between countries. To take advantage of these developments, many countries require a stronger capacity to access and use new tools, deal with intellectual property issues, and form productive partnerships with diverse actors in agricultural innovation systems, including the private sector.

A second trend involves the tendency for researchers to organize themselves increasingly around trans-disciplinary and multi-institutional teams. It is not always clear, however, what individual and organizational capabilities are needed to support the work of such teams.

Responding to these trends, CIAT will support scientific and technical training in diverse research areas. The Center’s advanced Bioscience Platform, for example, will enhance national partners’ ability to access and use new tools from molecular genetics and related fields. This facility will offer training in these areas, while also providing support in the handling of intellectual property and other management issues. In addition, the Bioscience Platform will improve national researchers’ access to advanced infrastructure and scientific advice for the implementation of research projects.

We will also identify a few high-priority capacity strengthening efforts, which respond to regional demands and help advance the strategic initiatives that CIAT intends to undertake. In its training efforts, the Center will rely on a wide range of university partnerships, which make important capacity strengthening opportunities more readily available to developing countries.

**Organizational change**

To make CIAT’s research more integrated and innovative requires organizational changes aimed at mainstreaming better collaboration. These changes include increased commitment to more horizontal forms of management and multi-sectoral partnerships, expanded use of monitoring and evaluation, and a stronger culture of learning and innovation.

To this end, CIAT will create new incentives and procedures to foster teamwork, while seeking an improved understanding of what agricultural research for development means in practice, what role formal research plays in innovation, and how trans-disciplinary and multi-institutional research teams can best be developed and supported. As the Center begins to design new strategic initiatives with partners, it will begin to build the internal capacities needed for more integrated research.

Moreover, CIAT will increasingly support innovation systems approaches, which take into account the views and needs of diverse research and development actors concerning problems,
alternative solutions, and the tradeoffs these may entail. The Center brings to this work a large body of experience in applying participatory research methods and tools to key tasks, such as varietal selection, value chain analysis, qualitative monitoring and evaluation, co-innovation, and knowledge management.

**Mainstreaming knowledge management for development**

Over the last decade or so, the field of knowledge management and knowledge sharing (abbreviated as KM) has moved from the margins to the center of strategic discussions in CGIAR. There is now wide agreement that improved KM is needed to foster learning among stakeholders in research for development. CIAT was among the first centers to pioneer KM approaches in CGIAR and, as a result, we have made significant progress in this area. For example, the Center actively uses social media for web-based discussions and content creation, and we employ collaborative practices and tools for online and face-to-face interactions. We have also helped develop innovative KM approaches, such as learning alliances and participatory impact pathway analysis, which have proven effective for enhancing development outcomes through continuous learning cycles. Nonetheless, we still have a long way to go toward incorporating KM principles and practices more thoroughly into our research agenda. For example, we can do a better job of sharing and discussing research progress with partners to speed the use of results and to reinforce learning. Likewise, through KM interventions aided by new information technologies, we can help improve smallholders’ access to resources that help them improve their farm productivity and competitive ability.

KM will also help CIAT create research products in a more collaborative manner that makes them more suitable for diverse audiences. For this purpose, we will make research data and results more readily available, in keeping with CGIAR policy on open access and data management. In addition, the Center will explore new KM and communications approaches for strengthening the influence of research results on the development of new policies and practices.

CIAT will take decisive steps during the period covered by this strategy to accelerate KM mainstreaming with respect to both the Center’s internal operations and the external networks through which our researchers work. For this purpose, the Center will steadily build the capacity of our staff to incorporate KM tools and methods into their work. As we become more involved in multi-stakeholder platforms that facilitate interaction and promote learning for change, it will be particularly important to improve the skills of our staff in facilitation, mentoring, and networking and in the use of social media and participatory research methods.
Eco-efficiency starts at home

To ensure effective implementation of our new strategy, CIAT will pay close attention to enhancing the efficiency of our internal operations. Given the eco-efficiency focus of our research, it is especially necessary that we apply this principle in our own work environment.

To this end, we will develop a better internal understanding of eco-efficiency and adopt appropriate business practices and policies, such as carbon-footprint standards and approaches to office-space design, renovation, and construction that do more with less. CIAT’s operations must be green, demonstrating sustainable practices in agricultural research and efficient use of resources (e.g., water and energy) to reduce our operating costs and environmental footprint. By 2015, CIAT expects to be a carbon-neutral organization, and we will strive to further reduce our carbon footprint by 2% annually.
The International Center for Tropical Agriculture (CIAT) – a member of the CGIAR Consortium – develops technologies, innovative methods, and new knowledge that better enable farmers, especially smallholders, to make agriculture eco-efficient – that is, competitive and profitable as well as sustainable and resilient. Eco-efficient agriculture reduces hunger and poverty, improves human nutrition, and offers solutions to environmental degradation and climate change in the tropics. Headquartered near Cali, Colombia, CIAT conducts research for development in tropical regions of Latin America, Africa, and Asia.
Building an Eco-Efficient Future
Member of the CGIAR Consortium

CGIAR is a global agricultural research partnership for a food secure future. Its science is carried out by the 15 research centers who are members of the CGIAR Consortium in collaboration with hundreds of partner organizations.