Chapter 3
Sustainable Rural Development in Rio de Janeiro State: The *Rio Rural* Program

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Abstract The eradication of hunger and poverty are part of the challenges established in this century by various countries as members of the pact to meet the global Sustainable Development Goals (SDGs). This pact is expected to strengthen agricultural production systems that can reverse environmental degradation with the adoption of agroecological technologies and greater social participation of actors historically excluded from public policies, such as family farmers, women, and rural youth. This chapter deals with the Sustainable Rural Development Program of Rio de Janeiro state – RIO RURAL – initially implemented as a pilot project and later transformed into a public policy of sustainable rural development with the support of the GEF and World Bank. The methodology adopted was built on community-based rural development in micro-watersheds, with the support of rural organizations and decision-making actors at local, municipal, and regional levels, to strengthen the beneficiaries' sense of governance and social management of the project. The financial resources are allocated to individual and collective projects with practices to encourage the agroecological transition of production systems, environmental adequacy of properties, water management, and conservation of rural roads. The autonomy of the project's actions has been built through co-investments and a varied establishment of partnerships.

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3.1 Introduction

The eradication of poverty and hunger through sustainable food production and consumption has been set under the framework of the global Sustainable Development Goals (SDGs). This commitment to supply the growing world population in an ecofriendly path is a challenge for several United Nations' member countries, including Brazil, within a scenario of scarce natural resources, degraded soils, loss of agro-biodiversity, and extreme climatic events (ONUBR 2016).

By 2030, signatory countries are committed to reach bold targets such as doubling agricultural productivity and income while ensuring food production systems that help maintain ecosystems and reverse land degradation with social and economic inclusion (ONUBR 2016). In order to achieve these results, the adoption of agroecological technologies will be required both in industrial and subsistence agriculture systems (IPES-Food 2016) as well as the engagement of historically excluded social stakeholders, such as smallholders, family farmers, rural women, and youth. To this end, governments need to provide technical assistance, credit, research, and infrastructure to support the transition to more sustainable systems, fostering public policies that value the territories and the role of family farmers responsible for supplying consumer markets.

In Latin America and the Caribbean, there are an estimated 17 million family production units with 60 million people, corresponding to 75–90% of all rural establishments in some countries in the region (Salcedo and Guzmán 2014; Sabourin et al. 2015). In addition to being the largest source of rural employment, they produce most of the food for domestic consumption and local markets in the region and usually develop diversified agricultural activities which give them a key role in ensuring environmental sustainability and provision of ecosystem services and supporting the conservation of biodiversity.

As in the entire Latin American and Caribbean region, family farming in Brazil is very expressive in socioeconomic terms and directly responsible for food and nutritional security of the population. It accounts for most of the basic food basket products, such as cassava, beans, milk, poultry, fruits, and vegetables. The family farmer sector is based on 4,367,902 production units which represent 84% of all rural units, with an average size of 18.4 hectares. Family farming covers 12.3 million people, making up 74.4% of the personnel employed in Brazilian agriculture. In terms of income, family-based agriculture generates a gross production value almost 90% higher than that of nonfamily agriculture (IBGE 2006).

The state of Rio de Janeiro (RJ) is the second smallest state in Brazil with only 0.5% of the country's territory. Despite its limited territorial dimension and the relatively low contribution of the agriculture sector to the state's GDP, the metropolitan region of Rio de Janeiro encompasses the country's second highest population and

consumer market, i.e., about 16 million people. Overall, 75% of the agricultural production in RJ is family-based (IBGE 2006) with a key contribution to the state's population food and nutritional security. Considering the enrollment of agro-industries in the food supply chain, the role of agriculture certainly goes well beyond its low participation in the state's GDP. Besides tomatoes and sugarcane, the main agricultural products in terms of income generated are fruit and vegetables, the latter mainly produced by family farmers (Barros 2013). Most of this production supplies the families of RJ with fruit and vegetables, also with milk and its derivatives. In the last 3 years, it also supplies state and municipal schools, as well as kindergartens and asylums through its insertion in institutional markets.

Historically RJ has undergone consecutive and unsustainable cycles of land use that led to deforestation, loss of biodiversity, soil erosion, and alteration of hydrological recharge processes, culminating in the degradation of natural resources in the Atlantic Forest biome and the impoverishment of the rural population (compare Ribeiro de Oliveira et al. 2018). In the beginning of the 2000s, the state government decided to undermine and reverse this path by setting efforts to establish a rural development approach based on sustainably raising agriculture productivity and restoring ecosystem functions, thus introducing a new perspective of wealthy and environmental-friendly well-being for the state's rural population.

3.2 The RIO RURAL Program

The Sustainable Rural Development Program of RJ – RIO RURAL – is a governmental program that aims to promote transition of conventional agriculture into agroecological and climate smart systems, thus supporting the increase of smallholders' income while reversing land degradation and improving resilience and biodiversity conservation in rural landscapes with the provision of ecological services in the Atlantic Forest biome.

Developed by the Rio State Secretariat of Agriculture, Livestock, Fishery, and Supply (SEAPPA) through its Superintendence of Sustainable Development, the Program has the outcome to reverse rural poverty and environmental degradation in biodiversity hotspots. The program envisions to support family farmers in the transition to more profitable and ecofriendly systems in order to meet the new market demands for cleaner and healthier food while linking farmers to key contemporaneous global issues, such as food security, solidarity economy, good governance, environmental services, climate change mitigation, and adaptation and biodiversity conservation.

The challenge to "produce and protect" goes beyond the simple application of stereotyped technological packages pressing the environment to adapt to them. It is a matter of adapting technology to environmental conditions and users. Moreover, to achieve long-term well-being, raising productivity should impact beyond positive economic results and deliver social and ecological benefits evenly. Key social engagement to promote this path requires strategies that are simple and participatory

in order to effectively address the sustainable use of natural resources. Using micro-watersheds as territorial units for planning and measure implementation allows for an attitude change in rural communities toward more profitable and environmentally sound livelihood, delivering healthier food and ecosystem services to society. In order to face this challenge, RIO RURAL adopted the "community sustainable rural development in micro-watersheds" methodology, an adaptation of the watershed sustainable management approach more suitable to rural areas. Adapted in Brazil in the early 1980s by rural technicians, the micro-watershed methodology builds upon participatory diagnosis and planning strategies and tools to address key social, economic, and environmental issues and guide territorial sustainable management while promoting community empowerment and good governance. RIO RURAL provides technical assistance, financial incentives, adaptive research, and capacity building to support adoption of agroecological technologies and natural resources conservation management practices in productive systems. It also enables farmers' social and economic inclusion through enhancing community self-management skills, productivity, and quality of agricultural products. Furthermore, RIO RURAL seeks to improve mobility, sanitation, and communication infrastructure in rural areas, aiming to facilitate farmers' access and more efficient linkages to markets.

Moreover, the program incorporates several methodological improvements, especially concerning the social dimension, such as community capacity building, environmental education, and dissemination activities, aiming to strengthening the role of social organizations in the decision-making process. The evolution of rural social groups' empowerment has been facilitated toward local sustainable development through the leverage of public and private co-investments and networking among farmers, scientists, and extensionists to improve exchanging and disseminating of agroecological knowledge. Additionally, the social engagement of farmers, women, and rural young people to local managers and technicians enables a democratic environment for a more efficient coordination of public policies and private partnerships that will provide sustainability to climate resilient, ecofriendly, gender, and economic inclusion of smallholders in the future.

3.2.1 Background, Rationale, Objectives, and Goals

RJ is entirely situated within the Atlantic Forest biome and hosts the largest portion of the Serra do Mar Corridor, considered to be one of the richest and globally most significant remnants of the original Atlantic Forest (Myers et al. 2000; Eisenlohr et al. 2015). Fortunately, some of these tracts are already being conserved in protected areas. According to Fundação SOS Mata Atlântica (2017), the RJ state territory encompasses less than 20% of native forest. Actually, within the state's territory rests a number of additional albeit smaller forest fragments, mostly on private lands. Despite the global significance of the biodiversity of the biome, these remnants are highly fragmented and threatened by (i) deforestation, primarily attributable to logging and charcoal production, i.e., in tropical moist broadleaf forests, and (ii)

conventional mono-cropping agriculture, i.e., in floodplain forests and grasslands, slash and burn for agriculture and pastures, i.e., in tropical semi-deciduous forests, and irrigated horticulture in fragile *restingas*, i.e., in coastal tropical and subtropical moist broadleaf forest and mangroves.

In the beginning of the 2000s, several constraints were affecting the effectiveness of the aforementioned responses to addressing the threats to biodiversity conservation while promoting sustainable agricultural practices included (i) an absence of policies and institutional frameworks promoting the incorporation of ecological considerations in agricultural production systems, (ii) limited human and financial resources to facilitate the integration of ecological and sustainability planning principles in sector policies and institutional processes, and (iii) the lack of alternative livelihoods relevant to communities living in proximity to areas of high biodiversity.

In order to face these constrains, the Rio de Janeiro Sustainable Integrated Ecosystem Management in Production Landscapes of the North-Northwestern Project (Rio GEF Project) was approved in 2005, a US$14 million grant that became effective in 2006, funded by the Global Environment Facility (GEF) with the World Bank as implementing agency and technical support of the Food and Agriculture Organization of the United Nations – FAO.

From 2006 to 2011, the Rio GEF pilot project was carried out to introduce new approaches to overcoming critical constrains in the state's hotspots areas in terms of endangered forest remnants, land degradation, and family farming. The Rio GEF Project provided technical assistance, adaptive research, financial incentives, capacity building, and training programs engaging more than 4000 farmers, technicians, and local managers in participatory diagnosis and planning processes, raising awareness of global environmental issues, and creating democratic decision-making spaces in 48 micro-watersheds and 22 municipalities. This enabling environment also supported the design of strategies and tools to implement a broaden public program – the RIO RURAL program – to promote integrated adoption of sustainable land management and natural resources conservation practices within the state territory (World Bank 2012).

3.2.2 Upscaling from the Pilot Project to a Public Policy

Based on effective results and impacts gathered during the Rio GEF Project, a loan agreement in the amount of US$79 million was approved by the World Bank in 2009. The loan project development objective was to increase the adoption of integrated and sustainable farming systems approaches in micro-watersheds, thus contributing to the higher-order objective of increasing small-scale farming productivity and competitiveness in the state.

The RIO RURAL program focuses on enhancing the entrepreneurial capabilities and opportunities available to small farmers for sustained improvements in their socioeconomic and environmental conditions via a participatory and decentralized

organizational framework. Within this approach, the program builds on the local and central institutional structures established under the Rio GEF Project to offer comprehensive and innovative support that addresses key rural sector challenges. For this purpose, the program has introduced and mainstreamed a new, integrated, and coordinated approach to public and private interventions within agricultural areas of RJ to maximize the impact and sustainability on a long-term basis.

In order to achieve these goals, RIO RURAL has established the following three pillar components (SEAPEC 2014):

- *Component 1*: *Supporting rural production and competitiveness* provides assistance to rural beneficiaries by working with community groups across local, municipal, and regional levels to increase organizational and participation skills through capacity building and planning activities. This component also aims to operate changes in rural production processes within a framework of market-driven agricultural development focused on sustainable and increased productivity of small farmers. It also helps to reestablish the productive environment of small farmers affected by the January 2011 natural disaster in the *Serrana Region*.
- *Component 2*: *Strengthening institutional frameworks* seeks to improve the state's institutional frameworks supporting market-driven agricultural development by (a) strengthening rural institutions and coordination mechanisms, (b) improving public and private financial support mechanisms, and (c) undertaking a participatory research network to facilitate agroecological knowledge transference between agriculture research and extension services and farmers.
- *Component 3*: *Project coordination and information management* supports overall project management, coordination and implementation, monitoring and evaluation, as well as dissemination of key sustainable rural development information under the project by financing (a) project coordination and (b) information management.

In the beginning of RIO RURAL implementation, in January 2011, unprecedented heavy rainfalls occurred in the *Serrana Region* of RJ with huge flooding and mudslides causing deaths and extensive damage to houses, roads, bridges, crops, and livestock affecting 11 municipalities in the region. Seeking at once for responding to the emergency needs, RIO RURAL was quickly restructured by the World Bank and Rio government teams to redirect almost US$ 19 million to support the resumption of on-farm productive endeavors and to restore farmers' mobility and access to markets. Most funding activities included rural roads restoration, recovery and rehabilitation of degraded lands, restoration of damaged houses, acquisition of productive assets and natural restoration of river banks and forests (CREA-RJ 2011).

The good performance of RIO RURAL's emergency support habilitated the state of RJ to proceed to an additional loan in an amount of US$100 million, complemented by US$40.5 million equivalent counterpart, for the additional financing of the RJ Sustainable Rural Development Program. Undergoing this additional loan credit operation, over US$213 million will be invested in RJ to benefit 85% of its

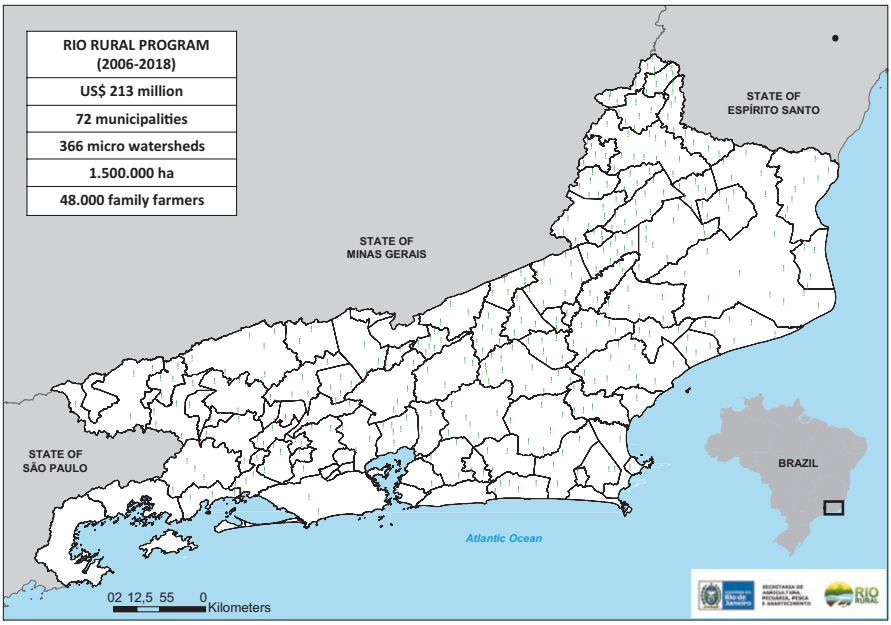

Fig. 3.1 RIO RURAL distribution throughout Rio de Janeiro State

rural population through 1.5 million hectares under improved production systems, i.e., 35% of the state area, as presented in Fig. 3.1.

By 2018, almost 48,000 family farmers living in 366 micro-catchments in 72 municipalities will be benefitted by RIO RURAL, 16,000 of which with direct financial incentives to support the transition to agroecological systems. About 34,000 km of rivers and 14,000 protected springs are expected to be more preserved by reducing organic and sediment load. Additional positive environmental effects rely on biodiversity conservation and climate change mitigation and adaptation in rural landscapes while cleaner and healthier food production will sustain food security in the state, benefiting the entire population of RJ. Most importantly, smallholders' economic inclusion and improved community empowerment will ensure good governance to sustain these results in the long term.

3.3 The Micro-Watershed Approach

RIO RURAL approaches focus on three foundation pillars – democratic, transparent, and decentralized management practices – aiming to improve governance at all territorial levels, i.e., micro-watershed, municipal, regional, and state levels. These pillars also seek to more efficiently implement and coordinate public polices and

private initiatives toward sustainable development. The strengthening of rural community's organizations at micro-watershed territorial level is a building block to the collective adoption of good and agroecological production practices allied to environmental conservation. This integrated approach will facilitate farmers' alignment to multilevel policies and initiatives focused on global development goals, mainly food security and provision of ecosystems services (MDG8 2015).

Each micro-catchment basin developed by RIO RURAL undergoes a process of democratic participation and decision-making through voluntary adherence to the program that involves communities and the local government. During the planning process, rural communities are stimulated to engage in a participatory diagnosis process and to establish a steering coordination body – the Micro-watershed Management Committee (MMC) – with representatives of all social diversity groups identified during the appraisal, aiming to improve governance and social engagement among all territorial levels. The program's main executing agencies are EMATER RIO and PESAGRO RIO, but the program also has several partners at local, state, and federal level like the Brazilian Agriculture and Husbandry Ministry (MAPA), the Federal Agriculture Research Agency (EMBRAPA), municipal governments, farmers associations and cooperatives, and universities, among others.

All program's executers and partners have been extensively trained since its beginning in order to ensure the application of key methodological principles, strategies, and tools while setting the stage. Mostly, capacity building challenged the introduction of participatory and community self-management/empowerment approaches adapted by the Technological Incubator of Popular Cooperatives ITCP/COPPE of the Federal University of RJ aiming to engage rural small farmers, women, and youth in democratic decision-making and monitoring toward their own sustainable development. Training also seeks to improve the technological base for agroecological transition, by changing the behavior not only among farmers but, also importantly, by delivering rural extension and agricultural research services.

3.4 Methodological Steps

In order to raise awareness among relevant stakeholders, to engage and empower rural communities into a democratic bottom-up decision-making to identify priorities, as well as to support transition to agroecological productive systems and conservation of natural resources in micro-watersheds, the RIO RURAL approach is implemented in the following four major phases (also presented in Fig. 3.2):

- Motivation phase: (i) presentation of the project, (ii) mapping and validation of all municipal watersheds, (iii) prioritization and selection of watersheds, and (iv) community engagement
- Planning phase: (i) preparation of Participatory Rural Appraisal (PRA), (ii) development of Executive Micro-watershed Plan (EMP), (iii) selection of beneficiaries, and (iv) development of the Individual Development Plan (IDP)

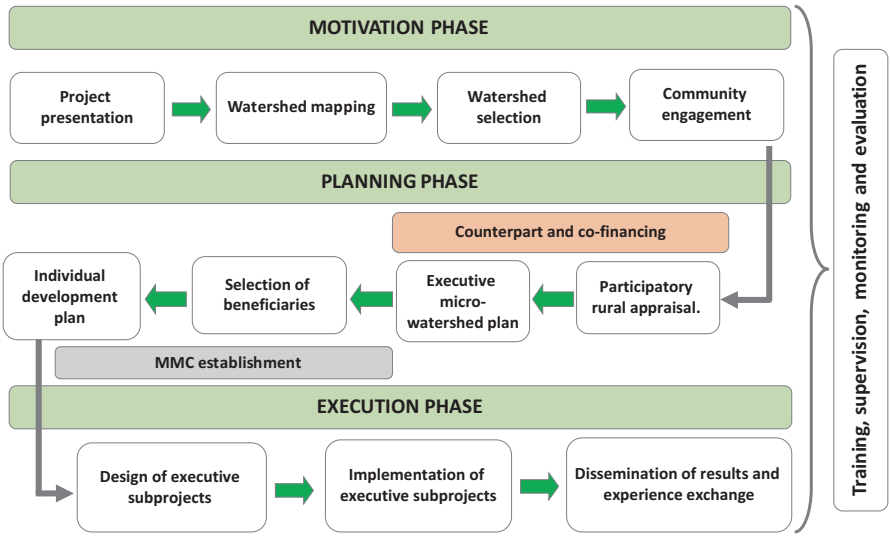

Fig. 3.2 Flow of the micro-watershed methodological approach (SEAPEC 2014)

- Implementation phase: (i) preparation of executive subprojects and (ii) implementation of executive subprojects
- Monitoring phase: (I) scientific monitoring system and (ii) participatory monitoring

During the planning process, both EMP and IDP are translated into business, individual, and group projects, the subprojects which are developed jointly between the executor technician, beneficiaries, and the steering committee (MMC). Investments in proposed subprojects are prioritized by rural communities within Rio Rural rules, boundaries, and lines of incentives agreed with the World Bank.

Each beneficiary shall voluntarily access the program's financial incentives, agreeing to adopt both sustainable productive and environmental practices. The aim of these incentives is to demonstrate that it is indeed feasible to conserve and produce simultaneously *at farm level.* RIO RURAL' s incentives also seek to stimulate the creation of more competitive, efficient, and empowered small business groups within rural farmers, women, and youth. Thus, higher amounts of financial resources are mainly canalized to collective entrepreneurship projects.

Executive subprojects are divided into the following four main categories: (a) sustainable productive subprojects, i.e., for sustainable intensification, adding value, and development of supply chains; (b) environmental subprojects, i.e., to support environmental adequacy of farms and agroecological transition; (c) rural roads; and (d) water management (Fig. 3.3a–d). Rio Rural also supports emergency interventions to combat the effects of drought and heavy rainfalls through encouraging actions that allow the prevention, mitigation, and adaptation to extreme events: water conservation, i.e., protection of springs, restoration of riparian forests, and

Fig. 3.3 Examples of subprojects supported by RIO RURAL: **a**) fence insulation to protect springs and water recharge areas, **b**) agroforestry systems, **c)** diversified agroecological production, and **d)** facilitated access to institutional school feeding program and local markets. Photos: Rio Rural

conservation of water recharge areas, building catchment infrastructure, storing and waterworks, such as deep tubular wells, and the construction and maintenance of dams, soil conservation practices, i.e., oil cover, counter line, crop rotation, no till, minimum till; agroforestry and silvopastoral systems among others that enable water infiltration and rational use of water resources in agriculture and livestock.

3.5 Results and Achievements

At the time of this writing, RIO RURAL is running in 373 micro-watersheds in 72 municipalities, covering almost 80% of the whole state's territory. Currently, 45,400 families of farmers and inhabitants are committed to program activities, and over 3500 farmers, women, and youth are participating in 366 Micro-watershed Committees that have already been established. More than 350 executive micro-watershed plans are designed driving communities' efforts to achieve local sustainable development. With financial incentives of the program, about 12,000 family farmers have already adopted sustainable productive systems in almost 100,000 hectares of land. Almost 35,000 subprojects, including sanitation, sustainable production, and environmental conservation practices and rural infrastructure,

have been incentivized, and 5700 km of rural roads have recovered, benefiting 28,000 rural residents. Table 3.1 shows RIO RURAL's main achievements by February 2017.

Table 3.1 RIO RURAL's main results (until June 2017)

RIO RURAL main achievements	
Result/achievement	Complementary information
32,400 smallholder farmers transitioned from traditional to sustainable agroecological farming systems	Financial incentives, capacity building, planning and research actions to promote changes in land management and adoption of good agricultural practices
More than a *100,000* ha of agricultural lands under sustainable production systems	Within *1,500,000* ha of land in micro-watersheds indirectly influenced by program actions
2400 small farmers with enhanced links to agricultural products value chains	Strategies and incentives to add value to small farmer's products and to facilitate access to new markets
373 micro-watershed committees organized and effectively implemented at community level	*360* micro-watershed executive plans and participatory rural appraisal elaborated at community level. More than **5000** rural women and youth being involved in local management decisions
More than *27,000* farmers, women, rural youth, technicians, and local stakeholders involved in capacity building events	More than *200* capacity building and training events were performed
52 participatory research fields	Participatory research trials carried out at small farmer level, adapting appropriate technologies in support of sustainable rural development
US $ 25.4 million of co-investments leveraged from various sources	This amount represents almost 15% of World Bank investments in the project. More than *150 territorial initiatives* were designed, 86 of which have successfully integrated co-investments funds
5700 km of rural roads maintenance and rehabilitation benefiting more than 30,000 people in rural areas	Rural roads rehabilitation and maintenance were carried out ensuring transport of goods, mobility of residents, and environmental protection (sediments reduction)
5000 springs protected and *4000* sanitation systems implemented in rural residences	Improvement in water quality and quantity along *34,000* km of rivers
32 soil conservation sets of equipment and machinery	Supported machinery acquisition and training to 32 farmer's associations in target micro-watersheds to improve soil conservation
Agroecological research network	The program strengthened an innovative network design involving 19 institutions, NGO's and farmers' organizations with focus on agroecology knowledge gaps
International and national *technical exchanges*	Exchange of experiences with Africa, India, Latin America, and other Brazilian federal states.

3.5.1 Capacity Building

As one of the most positive and long-term results, RIO RURAL program promoted a set of training activities to strengthen rural organizations and to improve community decision-making as well as to enhance local capacity toward transition to agroecological and environment-friendly rural landscapes.

The program's capacity building strategies focused on training of trainers, awareness raising, exchanging of experiences, field visits, and dissemination of good agricultural and agroecological practices. Main training topics have been related to the program's innovations, such as good governance, participatory approaches, community self-management, agroecological transition and environmental conservation practices, rehabilitation of rural roads, sustainability of food supply chains, and environmental education. Since 2010, more than 27,000 farmers, rural young people and women, fishermen, students, teachers, municipal managers and members of municipal councils of rural development, technicians, and local stakeholders have been democratically involved in more than 200 training events, meetings, lectures, and exchanging visits to raising awareness.

Furthermore, other relevant intangible results emerged from RIO RURAL's capacity-building actions – enhancement of community empowerment and engagement on local and regional social groups or steering committees; improved small business groups accessing markets more efficiently; gender empowerment, mainly through women participation in crafts and local markets; enhancement of organic certified groups; and leakage effect of voluntary adoption and expansion of environmental conservation practices.

3.5.2 Financial Incentives

In order to demonstrate that it is feasible to simultaneously produce safe food and protect the environment, RIO RURAL provides financial incentives and technical assistance to facilitate adoption of agroecological and conservation practices by smallholders. In return, farmers agree to implement environmental conservation and forest restoration practices in their lands with or without program's support. The overall program's results concerning financially incentivized practices are presented in Fig. 3.4.

In a range of the ten practices most demanded by farmers, i.e., 44% of the total, spring protection (fence insulation), conservation of water recharge areas (fence insulation), and recovery (afforestation) of riparian vegetation were the most accessed environmental practices making up 26% of the total. Key factors that may have contributed to raise farmers' interest in adopting sustainable and environmentally sound practices are as follows: (i) raised environmental awareness through RIO RURAL training events, (ii) increased climate concerns due to more frequent and extreme events, (iii) farmers' need to comply to environmental legislation in order to access rural credit federal polices, and/or (vi) recent market demands.

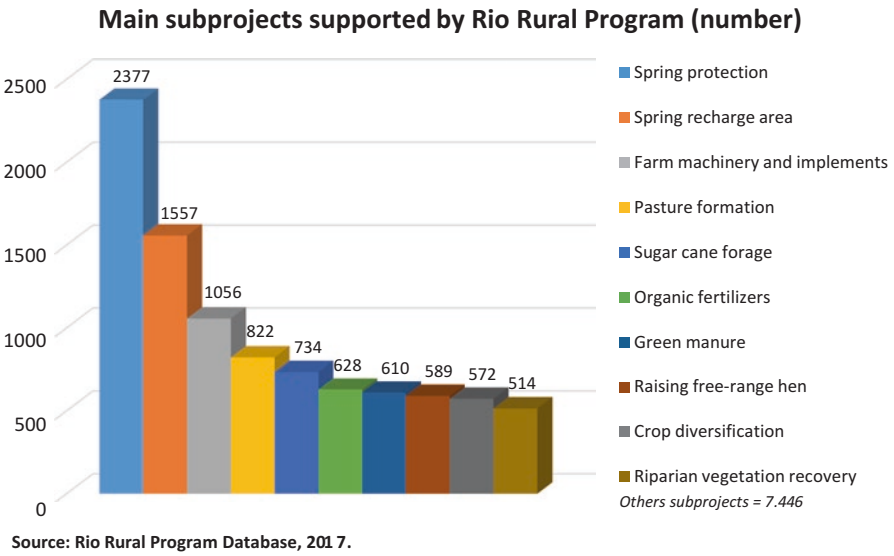

Fig. 3.4 Adoption of environmental and sustainable productive practices financed by RIO RURAL until February, 2017 (RIO RURAL Program Database 2017, unpublished)

Furthermore, a broad campaign for recovery and preservation of springs in rural areas was carried out by the RIO RURAL program on the eve of the 2016 Olympic Games.

Concerning adoption of sustainable and agroecological productive practices, pasture formation and sugarcane forage represented 9.2% of the total, which reflected the need of dairy farmers to climate adaptation after a 2-year drought period (2014–2015). Agricultural mechanization was also highly demanded, stressing a surrogate to labor scarcity and green manure and organic fertilizers, deeply related to the agroecological transition in horticulture systems – these subprojects represent 7.3% of the total. Farming diversification was also intensively accessed by beneficiaries in light of the crescent need for climate adaptation, albeit raising hens freely provided extra rural income, especially to women.

3.5.3 Co-investments

One of the most successful strategies implemented by the RIO RURAL program was the leverage of co-investments. These co-investments were integrated by public and private partners to enhance financial sustainability of the social, economic, and environmental services and results provided by smallholders. Furthermore, the co-investments aimed to supporting farmers with technical assistance, capacity-building, and public and private matching funds to ensure long-term results, far beyond RIO RURAL's implementation period.

These funds were identified upon community demands raised during the planning phase, recorded on the PRDs (participatory rural diagnosis) and consolidated in the MEPs (micro-watershed executive plans). From 2007 to 2016, the RIO RURAL program, through its beneficiaries, technicians, and researchers, has designed more than 150 territorial initiatives to leverage co-investment funds, 86 of which have successfully managed to raise approximately US $ 25.4 million in co-investments from various sources. This represents almost 15% of World Bank's investments, which indicates a fruitful and promising way of sustaining these actions in the future.

The cooperation of RIO RURAL with German universities and small enterprises under INTECRAL project is a successful example of leveraging of co-investments from the German Federal Republic government to undergo complementary studies and knowledge transfer to improve natural resources management and the provision of ecosystems services in the Atlantic Forest biome while overcoming research gaps to facilitate adoption of good agriculture practices in a more sustainable rural development economy.

All these partnerships reinforced the main strategy of seeking for financial sustainability to rural development activities beyond the end of the project, generating an evolutionary process through the local watershed committees, using participatory planning tools to match partnership funds and empower rural communities. However, most of these co-investments were derived from public initiatives, indicating an urgent need to a stronger commitment of the private sector.

3.5.4 Environmental Services

Undoubtedly, farmers' transition to agroecological and more environmental-friendly productive systems improves environmental services and availability of water, forests, biodiversity, safe and nutritious food, as well as climate resilience, benefiting the whole society. These services shall be compensated through public or private support to ensure its provision in a long-term basis.

Agroecological soil and crop management, agroforestry and silvopastoral systems, and forest conservation and restoration practices improve carbon immobilization in rural landscapes and reduce emissions of greenhouse effect gas by agriculture sector. In addition, besides several climate adaptation and diversification of production systems (Torres and Dornberger 2018), the program also encouraged farmers to take on preventive measures in relation to the interaction with the growing climate instability and soil degradation, reducing their vulnerability to such factors (Seliger et al. 2018).

Several rural communities engaged in the RIO RURAL program have successfully established partnerships with watershed committees, schools, hospitals, restaurants, and local markets in order to provide clean water and organic and safe food.

Moreover, RIO RURAL joins additional efforts to enhance financial sustainability of payment for ecosystems services (PES) schemes to support farmers' adoption of sustainable intensification technologies in compensation to their environment conservation actions. In the recently approved GEF Project "Recovery of Climate and Biodiversity Services in the Paraíba do Sul River Basin in the Brazilian Atlantic Forest," US$ 14.39 million grants will be invested from 2017 to 2022 in the state's northwestern and southern regions; part of the counterpart will be financed by RIO RURAL. The main objective of this new project is to pilot a PES scheme that will integrate both agriculture and environmental funds. While RIO RURAL will support farmers' environmental compliancy, PES will canalize funds to farmers' technological jump and rise in productivity and income. In counterpart, farmers will commit to preserve ecosystem services associated to biodiversity conservation and carbonization in critical rural landscapes of the Brazilian Atlantic Forest Southeastern Corridor.

3.5.5 Agroecological Technologies Research Network

Another challenge to long-term rural development outcome is how to maintain and expand the systematic provision of extension services and research focused on developing agroecological technologies tailored to the small farmers. These services are essential once they provide essential knowledge and key information to qualify agriculture products and raise competitive access of small farmers to markets. To this end, RIO RURAL has established an agroecological network based on partnerships among research, extension, farmers' associations, and development institutions, both nationally and internationally.

The RIO RURAL agroecological network was established to overcome the technological gap and facilitate knowledge transfer among researchers, extensionists, and farmers. Using an innovative and collaborative way of network training, the agroecological network focuses on horizontal exchanging of sustainable agriculture management practices knowledge to support and facilitate agroecological transition of production systems.

3.6 The Way Forward

The transformative seed capital nested through a long-term public program such as RIO RURAL will simply initiate a process that shall afterward rely upon solidarity, social responsibility, and collaborative networking to sustain alliances between end consumers and producers to long-term provision of goods and services. Public and private partnerships will also have to be envisioned to necessarily improve governance toward better managed and climate-resilient landscapes.

Simplified compensation mechanisms shall be designed in a near future to facilitate rural communities' access to collaborative financial schemes that will provide technical assistance and financial incentives to support their transition to a more productive, sustainable, and climate-smart agriculture.

Another challenge will be to strengthen rural infrastructure and communication networks to reduce asymmetries of information and to improve farmers' access to markets. By creating accreditation tools, solidarity markets, e-commerce, and negotiation platforms, the geographical and cultural gap shall be overcome, uniting producers and consumers, creating spaces of collaborative technical assistance, rural extension, and research approaches, attracting public policies and private companies. The main focus shall be to improve market access and knowledge sharing on practices, technologies, and sustainable agricultural systems, joining efforts with NGOs, private sector, and research institutions to ensure smallholders sustainability.

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