1.1. What are the objectives, activities and expected impacts of the FSPI components ?

The components correspond to the different themes or axes of the project. They contribute to the objective of the project (3.1) and are 3 in number (excluding aspects related to management which are dealt with in a dedicated chapter)

Component 1

Objectif of the component

Biochar: this component aims to validate and promote biochar among small-scale farmers in Busia, Kisumu and Siaya counties, in order to increase their food and nutritional security and improve their incomes and environment.

Planned activities

1-1: Validate and develop biochar for small-scale farmers

Activity 1-1-1. Field visits to identify project sites

The project team will visit Busia, Kisumu and Siaya counties and select one village for each county on the basis of: (1) their representativeness, (2) the level of food insecurity, and (3) the presence of complementary agricultural development initiatives. The team will also visit sugar mills and rice irrigation systems in the three counties to confirm the availability of bagasse and rice husks. This activity will take place during the first week of the project and will be led by KALRO.

Activity 1-1-2. Establish baseline conditions and define indicators to measure change

A baseline survey will be conducted at the start of the project. It will serve as a benchmark for measuring the project's achievements and results. A structured questionnaire will be administered electronically in the three counties using smartphones. Data will be entered and processed using Open Data Kit (ODK) software. Embu University, Koitaleel Samoei University College and Ungana Ltd will jointly implement this activity.

Activity 1-1-3. Stakeholder meeting (components 1, 2 and 3)

The project will hold a stakeholder meeting at the start of the project to confirm project sites, identify and prioritize biochar interventions for scale-up, adopt the baseline report and develop a performance monitoring plan, refine project objectives and develop work plans with clearly defined roles and responsibilities. A second meeting, involving decision-makers at the end of the project, will share results and facilitate handover. This activity will be led by Koitaleel Samoei University College. To facilitate women's responses, female students will be involved throughout the project (see 1-1-5).

Activity 1-1-4. Validate biochar production

The project will evaluate existing biochar production machinery to determine the most efficient, cost-effective and farmer-friendly machines for adoption and scale-up under the project. This activity will be carried out early in the project and will be co-led by Koitaleel Samoei University College.

Activity 1-1-5. Capacity-building for students

Four young female students will receive support for their master's degree. The aim is to train specialists in the production and application of biochar at local and national level. They will work on GHG emission measurements and modeling of the long-term effect of different biochars on carbon sequestration, determination of factors influencing the adoption of different biochars in target counties, economic evaluation of biochar technologies, effects of different biochars on soil fertility, hydrology and crop yields. This activity will be co-led by the University of Embu and the University of Nairobi.

Activity 1-1-6. Measure, model and extrapolate the effects of biochar on soil carbon balance and biodiversity

Using soil carbon measurements and soil respiration rates with and without the biochar amendment as a reference, simple models of soil organic matter decomposition are used (single-box models, AMG, MOMOS) to compare treatments and extrapolate over a longer period to assess the long-term effects of the amendments on carbon sequestration. This work will be carried out with a Master's student. The activity will be implemented during the second year by CIRAD and IRD in partnership with KALRO and Egerton University, in connection with activity 2.3.

Activity 1-1-7. Set up trial fields

The project will adopt a participatory learning and research approach to promote the agricultural use of biochar in support of other yield-enhancing technologies. The application of biochar is to be integrated with other technologies, which will be selected on the basis of their ease of adoption, the investment required and their compatibility with biochar. On-station and on-farm trials and demonstrations will be carried out in a participatory manner, taking into account the biophysical, socio-economic and cultural conditions of each project site in the three counties. Data on crop yields, soil chemical and physical properties, greenhouse gas

emissions, biochar cost and yield will be collected through these trials and demonstrations, analyzed and shared with farmers and other stakeholders at the end of each growing season. This information will enable farmers and other stakeholders to understand the additional costs involved in the sustainable production and application of biochar, as well as the benefits that may accrue. In addition, the on-station and on-farm trials will provide areas of research for the Masters students that the project will support. A study will be carried out at the end of the project to determine the degree of biochar adoption and its impact. This activity will take place over at least three seasons and will be co-directed by KALRO and Dr. Getrudis Penton Fernandez of the Latin Biochar Network in Cuba. To make it easier to take into account the point of view of women farmers, this activity will be supervised mainly by women researchers and students.

Activity 1-1-8. Capacity building and comparative analysis

Exchange visits to Cuba and to the Kouros company in France will be organized to enable the project team to gain more experience in sustainable commercial production and biochar management. This activity will take place at the beginning of the project and will be coordinated by IRD.

1-2. Support evidence-based policy on intensive agricultural use of biochar in Kenya.

Activity 1-2-1: Develop a communication strategy

A study of target audiences will be carried out at the start of the project to identify their information needs, preferred dissemination channels and media, as well as expected behavioral changes and feedback mechanisms. The stakeholder analysis will also serve as a basis for formulating a communication strategy for the project's various deliverables. This activity will be carried out by Koitaleel Samoei University College.

Activity 1-2-2. Renovate and equip existing village information centers

The project plans to refurbish and equip village information centers established in the three counties by the Kenyan Ministry of Information and Communication Technology (ICT) to widely disseminate information on biochar production and benefits. This activity will be carried out by Koitaleel Samoei University College.

Activity 1-2-3. Conduct awareness programs

The project proposes to record videos of some of the sustainable biochar production and management practices, as well as farmer training sessions, which can be viewed and broadcast on local radio stations and national television. In addition, the project will organize exchange visits and field days for male and female farmers to empower communities and raise awareness of the benefits of biochar. Promotional materials such as posters and brochures will be developed and translated into local languages and distributed in the three counties and beyond. This activity will be carried out by Koitaleel Samoei University College.

Activity 1-2-4. Scientific publications and presentations at scientific conferences

The preliminary and final scientific results of the project will be presented at local and international conferences and workshops. In addition, the project's scientific results will be published in international peer-reviewed journals to disseminate them to the scientific community. These activities will take place throughout the project and will be coordinated by KALRO, Embu University, Koitaleel Samoei University College, CIRAD and IRD.

Achievements, outcomes and expected impacts

Note: the indicators must reflect the completeness of the expected outputs and results

Output indicators *(refers to the goods and services delivered by the component)*

Formulate the indicator by mentioning the quantitative and/or qualitative targets to be reached.

1-1-1 : Carrying out a one-week field mission for 3 people

1-1-2 : Survey conducted in the 3 counties, baseline conditions established and indicators to measure change.

1-1-3 : A one-week workshop is organized, 1 work plan with clearly defined roles and responsibilities, indicators for measuring change are defined, A one-day meeting is organized at the end of the project, bringing together around 30 people.

1-1-4 : 2 one-week field trips are organized.

1-1-5 : 4 Master's students receive support for their fieldwork.

1-1-6 : 10 scientists, including at least 5 women, are trained in modeling and simulation.

1-1-7 : 500 farmers, including 250 women and 300 young people under the age of 30, are trained in the production and use of biochar.

1-1-8: 6 research trips, including at least three for female researchers, are carried out in France and Cuba.

1-2-1: 1 strategy is defined

1-2-2: 3 village information centers set up.

1-2-3: 6 local radio stations broadcast programs on biochar, and 5,000 brochures, 100 posters and 10 kakemonos are produced.

1-2-4: 1 presentation at a scientific conference and 3 scientific articles published

Outcome indicators *(refer to the short and medium term effects on the direct beneficiaries of the activities)*

Formulate the indicator by mentioning the quantitative and/or qualitative targets to be reached.
1-1-1 : 3 appropriate villages identified
1-1-2 : Successful project implementation
1-1-3 : 3 county governments are aware of the benefits of biochar, sites and processes validated by stakeholders. Project replicated in other counties.
1-1-4 : The biochar production process at the sites is validated.
1-1-5 : 4 female students are trained in biochar production and can be mobilized as experts.
1-1-6 : 10 scientists are trained to simulate greenhouse gas emissions, reducing the cost of biochar experiments.
1-1-7: 30% increase in yields and 20% increase in income for farmers using biochar.
1-1-8: 3 scientists, including 2 women, trained in more efficient biochar production methodologies.
1-2-1: an appropriate and effective communication policy is implemented.
1-2-2: 500 farmers in the three target counties, including 250 women and 300 young people under 30, produce and/or use biochar.
1-2-3: 10,000 people receive information on biochar.
1-2-4: Knowledge of biochar spreads in the scientific community and Kenyan expertise is recognized.

Impact indicators *(refers to the more distant and general effects that may be generated)*

Formulate the indicator by mentioning the quantitative and/or qualitative targets to be reached.
30% increase in the number of farmers using biochar in the three target counties two years after the end of the project.
Food security in Busia, Siaya and Kisumu counties is enhanced.
Soil health restored.
500 farming households in the target counties see their standard of living rise significantly and sustainably.

Sources used to collect information for the indicators

- Government statistics on food and nutrition security and incomes
- Project monitoring and evaluation reports
- Baseline surveys and impact assessment reports
- Peer-reviewed publications.
- Students' master's theses
- Audience measurement for local TV and radio stations

Component 2 **Insect-composted organic fertilizer (ICOF)**

Objectif of the component

Advance the development and use of insect-composted organic fertilizers (ICOF) to improve soil health and crop productivity for food security in a context of climate change.

Planned activities

Activity 2.1. Map organic waste suitable for breeding black soldier flies (*Hermetia illucens*) and develop diversified ICOF products to meet production requirements.

In collaboration with male and female farmers, a survey will be carried out to identify the organic waste channels available in the target counties (Kisumu, Busia and Siaya). Experiments will be conducted to determine the most efficient and cost-effective method of composting black soldier fly excrement into a mature, stable organic fertilizer with high nutritional levels and maximum hygiene standards using locally available materials. The ICOF products developed will be checked for compliance with Kenya Bureau of Standards guidelines.
Genomic analysis of the microbial composition of the generated ICOFs, including pathogenic bacteria, fungi and viruses, will be carried out to verify the safety of ICOFs for agricultural production, soil health management and health. In addition, the genetic diversity and symbionts of black soldier fly species used in waste bioconversion will be assessed to determine the suitability of different organic wastes for feed and fertilizer production. This information will be used to develop innovative ICOF products such as powdered ICOF for annual crops, liquid ICOF for fertigation, and chitin-fortified ICOF products for pest and disease control.
This activity will be carried out during the first semester of Year 1, and will be implemented by ICIPE in collaboration with black soldier fly producers, local managers, waste management companies and students from partner universities. The majority of students recruited for the study will be women, in order to facilitate consideration of women farmers' points of view.

Activity 2.2. Set up pilot training and demonstration facilities for ICOF production

Using the results obtained under Activity 2.1, training and demonstration facilities on black soldier fly cultivation for organic fertilizer production will be set up in each target county. Farmers will receive hands-on training on the step-by-step procedures of breeding black soldier flies for fertilizer. Training will be offered in local languages to facilitate communication. Farmers and entrepreneurs will be encouraged to participate in the various activities of the black soldier fly value chain. The project will optimize low-cost, low-energy post-harvest processing

instruments for ICOF production, such as grinders in small-scale production units.
This activity will start in the second half of year 1 and continue for the rest of the project duration. The activity will be implemented by ICIPE in partnership with farmers and black soldier fly producers (Hydro Victoria Fish Hatchery Farm and El Paj Gardens Ltd.), and agricultural extension agents in the target counties.

Activity 2.3: Evaluate ICOFs using a multi-criteria mechanism in a network of dynamic cropping systems.
The criteria for selecting the cropping systems making up the network will be defined at a workshop with farmers from Siaya, Busia and Kisumu. Each type of cropping system will be represented by at least 5 fields from farmers who have agreed to take part in the experiment. Two plots with and without ICOF will be set up in each field at the start of the growing season. Other technical interventions in the fields will be carried out at the farmers' initiative. A selection of indicators relevant to the study area will be collected in the fields using Biofunctool®, a new tool for assessing the impact of land management on soil quality, as well as socio-economic indicators (gross margin, return on investment, labor productivity).
All the indicators used are low-tech, inexpensive and effective for assessing these functions and soil health. Biofunctool® training will be offered to local technicians, scientists and students. The activity will be implemented from the second year onwards by ICIPE, KALRO, Egerton University, Kenyatta University, CIRAD, IRD in partnership with farmers and extension agents in the target counties. Activity linked to activity 1-1-6. The training courses will be run and implemented by women and will be organized outside school vacation periods to facilitate the participation of women farmers.

Activity 2.4. Measure, model and extrapolate the effects of the ICOF amendment on carbon balance and soil health
Taking soil carbon measurements and soil respiration rates with and without the ICOF amendment as a reference, simple models of soil organic matter decomposition are used (single-box models, AMG, MOMOS) to compare treatments and extrapolate over a longer period to assess the long-term effects of the amendments on carbon sequestration. This work will be carried out with a Master's student. The activity will be implemented during the second year by CIRAD and IRD in partnership with ICIPE, KALRO and Egerton University, in connection with 1-1-6.

Achievements, outcomes and expected impacts
Note: the indicators must reflect the completeness of the expected outputs and results

Output indicators *(refers to the goods and services delivered by the component)*

Formulate the indicator with quantitative and/or qualitative targets to be reached
2-1: an inventory of waste suitable for ICOFs is drawn up for each county, 3 ICOF products are developed, 2 students, including at least one woman, are supported, a minimum of 1,000 samples are analyzed, 2 articles published in peer-reviewed journals, participation in an international conference.

2-2: 3 ICOF demonstration facilities installed in target counties, 3 owners of a demonstration facility, including at least one woman, receive a week's training at ICIPE, 12 banners, 2,000 brochures and 3 posters produced and distributed, 2 radio programs produced and 50 spots broadcast per county, one ICOF report published.

2-3: 5 demonstrations on agricultural production using ICOFs set up in each county, at least one field visit organized per county, at least 2 success stories using ICOFs presented in the media, 2 master's students, including at least one woman, supported, at least 2 articles published in peer-reviewed journals.

2-4: One report on the long-term impact of ICOFs on soils published, one article published in a peer-reviewed journal.

Outcome indicators *(refer to the short and medium term effects on the direct beneficiaries of the activities)*

Formulate the indicator with quantitative and/or qualitative targets to be reached
2-1: Identification of organic waste best suited to fertilizer production using black soldier flies, expansion of the diversity of ICOF products, improvement in the use of organic waste in target counties.
2-2: At least 500 farmers, including at least 250 women and 250 young people under 30, are trained in the production and use of ICOF, 3 NGOs receive training in ICOF and its production, at least 100 tonnes of solid ICOF and 1000l of liquid ICOF produced.
2-3: Food crop yields of farms using ICOFs increase by at least 10%, significant improvement in the nutritional quality of food crops, profit margins of ICOF producers increase by at least 5%, increase in ICOF production and utilization capacities by at least 30% in the three target counties.
2-4: increase in ICOF production and utilization capacity by at least 30% in the three target counties.

Impact indicators *(refers to the more distant and general effects that may be generated)*

Formulate the indicator with quantitative and/or qualitative targets to be reached
Significant improvement in ICOF quality
Generalization of ICOF production and marketing in the three target counties.
20% increase in the number of farmers using ICOF within two years of the end of the project.
Enhanced food security

Poverty reduction Enhanced soil health, biodiversity and resilience to climate change
Sources used to collect information for the indicators
Laboratory analyses Reports from demonstration facilities and training sessions. Project progress reports Structured interviews with beneficiaries Laboratory analysis reports Farmer testimonials collected during the project.

Component 3

Objectif of the component

Increase income from organic waste innovations such as insect-composted organic fertilizer (ICOF), biochar for participating households, agro-traders, youth, women and manufacturers. This component will be implemented in Busia, Kisumu and Siaya counties, with the possibility of spillover into neighboring regions rich in agricultural organic waste, including Transmara, Bungoma, Kericho and Migori.

Planned activities

3-1: Promote the sustainable supply of ICOF, biochar to farming communities in the target counties of project implementation - Busia, Kisumu and Siaya

Activity 3-1-1: Carry out an economic baseline study on ICOF processing and application, bagasse supply and demand, biochar production from different sources (bagasse, rice husks and other agricultural waste), as well as an economic and market analysis of the targeted products. The activity will be implemented at the end of the first year/beginning of the second year of project implementation, and will be carried out jointly by Embu University, KALRO, Koitaleel Samoei University College and ICIPE. To encourage women's responses to be taken into account, the majority of interviewers will be women.

Activity 3-1-2: Training workshop to strengthen partnerships with the private sector, focusing on small and medium-sized enterprises run by women and young people, in order to facilitate business incubation, production and distribution of commercially viable products (ICOF, biochar). The workshop will also include agricultural traders who will facilitate the distribution and marketing of both products. This activity will be led by Koitaleel Samoei University College with support from Embu University, KALRO, ICIPE and the Kouros Bio-Kenchar project and will start at the beginning of the second year of the project.

Activity 3-1-3: An online course will be proposed for the Open University of Kenya (OUK) to develop an online course on the efficient use of agricultural waste. This activity will be developed by Koitaleel Samoei University College.

Activity 3-1-4: Install machinery for testing (components 1 and 2) and commercial production of ICOF, biochar with a view to forming village cooperatives. This activity will include: purchasing or manufacturing and installing production equipment for ICOF, biochar in Busia, Kisumu and Siaya counties, developing a pricing strategy, developing labeling and packaging materials, and obtaining approvals from the Kenya Bureau of Standards. The activity will start at the beginning of the project for the installation of the equipment, and at the beginning of the second year, after trials and validation tests, for the setting up of the cooperatives. This activity will be carried out by Koitaleel Samoei University College in collaboration with KALRO, Embu University, ICIPE and the Kouros Bio-Kenchar project.3-2: Improve employment opportunities for women and youth along the ICOF and biochar value chains in Busia, Kisumu and Siaya counties.

Activity 3-2-1: Practical training for women and young people to develop their entrepreneurial skills. The training sessions will be led by women trainers and will be organized outside school vacation periods to facilitate women's participation. This activity will include: developing digital and non-digital training manuals and training trainers; equipping, through training, existing business development centers or incubators to mentor and support aspiring and active entrepreneurs in the ICOF and biochar value chains in the three counties; forming women's and youth cooperatives for resource pooling and collective bargaining power. This activity will include registering interested women's and youth groups as business entities, developing skills in group management, accountability and governance. These activities will be launched at the beginning of the second year of the project and will be led by Embu University with the participation of ICIPE, Koitaleel Somoei University College, KALRO and the Kouros Bio-Kenchar project.

Activity 3-2-2: Train 3 masters or PhD students, including at least 2 women, on marketing, production and distribution of ICOF, biochar; market analysis and supply chain economics. Embu University will lead this activity in collaboration with ICIPE, KALRO and Koitaleel Samoei University College.

3-3 Strengthen evidence-based policy formulation and planning for the production and marketing of ICOF, biochar.

Activity 3-3-1: Raise awareness among policymakers, planners and political leaders, through workshops and roundtables, of the need to develop policies and regulations that promote the wider use of ICOF and biochar to improve food security and create climate-resilient ecosystems. The activity will be led by Embu University with participation from ICIPE, KALRO, Samoei Koitaleel University College.

Activity 3-3-2: Disseminate project results on the commercialization of ICOF and biochar through participation in scientific conferences, workshops and other appropriate forums to share results.

Achievements, outcomes and expected impacts

Note: the indicators must reflect the completeness of the expected outputs and results

Output indicators *(refers to the goods and services delivered by the component)*

Formulate the indicator with quantitative and/or qualitative targets to be achieved

3-1-1: At least 3 written reports shared with project parties on marketing, market analysis and supply/demand dynamics of ICOF and biochar.

3-1-2: At least one week of training is organized, 20 farmers, including 10 women, are trained in entrepreneurship, an online module is designed.

3-1-3: At least one teaching module on biochar and ICOF is created and put online by OUK.

3-1-4: At least 3 ICOF and biochar production facilities are set up, one in each county, and 3 production cooperatives are created and 3 products are launched for commercial production.

3-2.1: At least 6 trainers, including at least 3 women, are trained, and a series of six 3-day training workshops are organized in target villages.

3-2-2: 3 Masters or PhD students, including at least 2 women, are trained in economic analysis and entrepreneurship.

3-3-1: At least 4 roundtables were organized with the participation of 20 county leaders, 3 members of parliament, 20 project participants, 3 members of the county assembly, with at least 50% women among the participants, and 3 policy briefs were produced.

3-3-2: At least 2 participations in scientific conferences, at least 4 scientific articles published in peer-reviewed open-access journals.

Outcome indicators *(refer to the short and medium term effects on the direct beneficiaries of the activities)*

Formulate the indicator with quantitative and/or qualitative targets to be achieved

3-1-1: Project participants have a clear understanding of the opportunities and obstacles to marketing ICOF, biochar in Busia, Kisumu and Siaya counties.

3-1-2: at least 20 farmers, including 10 women, are trained and share a common vision of marketing biochar and ICOF.

3-1-3: Opportunities related to biochar and ICOF are disseminated to the agricultural science student and teaching community.

3-1-4: ICOF and biochar benefit from efficient production and distribution channels in the three target counties.

3-2-1 : At least 6 trainers, including 3 women, can accompany farmers wishing to start marketing biochar or ICOF, or other innovative organic inputs.

3-2-2: 3 experts, including 2 women, are trained and can act as resource persons.

3-3-1: Counties take into account ICOF and biochar in their policies to strengthen food security and soil restoration.

3-3-2: The scientific community has access to the results of the project on strengthening farmers' economic capacities.

Impact indicators *(refers to the more distant and general effects that may be generated)*

Formulate the indicator with quantitative and/or qualitative targets to be reached

Household food security in the target counties is enhanced.

Income-enhancing solutions linked to the production and use of biochar and ICOF are well known and mobilized, particularly by young people and women from farming households.

Resilience to climate change is strengthened.

The project is being replicated in other counties and countries.

Sources used to collect information for the indicators

- County development plans and reports
- National statistics on food poverty and hunger indices
- Data collected during project research
- Evaluations during and after training courses

1.2. What are the main risks that cannot be controlled at the design stage and what measures have been planned for to limit them ?

Uncontrollable risks In the case of a project, the changes in the context (political, social, economic, health crisis, etc.) may affect very different aspects. Examples: A change in the context (political, social, economic, health crisis, etc.). A prerequisite or condition that depends on a partner (development of legislative or regulatory texts, allocation of human resources or specific means). Technical difficulties (particularly for projects using digital tools). Shortcomings of partners responsible for the implementation of activities. Difficulties related to the identification and mobilisation of beneficiaries or to the management of the project (compliance with deadlines, erroneous forecasts, budgetary difficulties; objectives that turn out to be unrealistic, low involvement of stakeholders).

***Please note** : risks identified and manageable at the project design stage do not need to be detailed in the table below. This is because these risks are assumed to have been taken into account in the definition and implementation conditions of the funded activities.*

Identified risks	Measures planned to mitigate the risks
Risk 1 Government intervention in the agricultural market through subsidies, donations or price controls on chemical inputs, or bans on sales of agricultural products from certain localities.	The project includes dialogue with political authorities, particularly at county level.
Risk 2 Farmers' refusal to change their practices	Participatory approach involving training and awareness-raising. Product development by farmers themselves.
Risk 3 Appearance of plant pests and diseases, e.g. cassava brown streak virus, maize lethal necrosis, potato late blight, rice yellow mottle virus and locusts.	The project leaders are in close communication with national and international research institutions and plant protection agencies to identify early warning signals.
Risk 4 Climate change and catastrophic weather events.	The project will address climate-induced risks using seasonal forecasts and weather warnings.