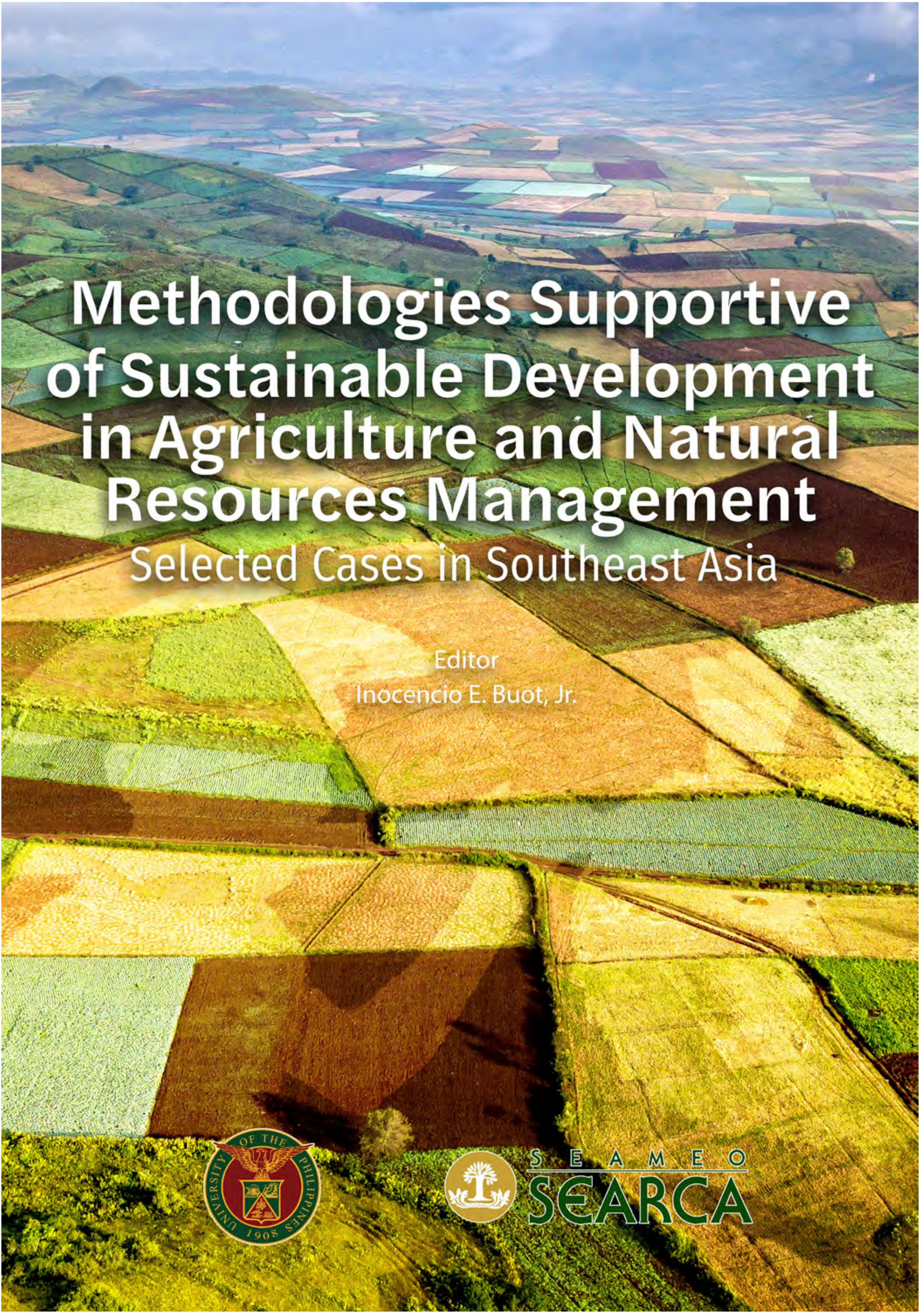

Methodologies Supportive of Sustainable Development in Agriculture and Natural Resources Management

Selected Cases in Southeast Asia

Editor
Inocencio E. Buot, Jr.

UNIVERSITY OF THE PHILIPPINES 1908

SEAMEO SEARCA

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The Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) is one of the 26 specialist institutions of the Southeast Asian Ministers of Education Organization (SEAMEO). Founded on 27 November 1966, SEARCA is mandated to strengthen institutional capacities in agricultural and rural development in Southeast Asia through graduate scholarship, research and development, and knowledge management. It serves the 11 SEAMEO member countries, namely, Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, the Philippines, Singapore, Thailand, Vietnam, and Timor-Leste. SEARCA is hosted by the Government of the Philippines on the campus of the University of the Philippines Los Baños (UPLB) in Laguna, Philippines. It is supported by donations from SEAMEO members and associate member states, other governments, and various international donor agencies.

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Foreword

Methodologies Supportive of Sustainable Development in Agriculture and Natural Resources Management: Selected Cases in Southeast Asia is the maiden book writing project of the Regional SEARCA Alumni Association (RSAA), authored by selected SEARCA alumni from the Philippines, Thailand, Vietnam, Indonesia, and Lao PDR. The RSAA (formerly known as the Regional SEARCA Fellows Association or RSFA) is SEARCA's valuable network of alumni that works toward sustainable agricultural and rural development through conferences, seminars, and collaborative research projects that bring together experts in the region.

This publication presents a compendium of relevant methodologies used by the authors for their research in select Southeast Asian countries to tackle the challenges that impinge on sustainable development. It illustrates the practical application of various research methodologies and evidence-based decision making to enhance the rigor of studies in the field of agriculture and natural resources management. As the region confronts the dynamic nature and magnitude of competition for dwindling resources caused by climate change and biodiversity loss, the publication pushes for research methodologies that are supportive of sustainable development and grounded on local realities.

The book is divided in two categories: (a) "Methodologies Supportive of Sustainable Development in Agriculture Management" and (b) "Methodologies Supportive of Sustainable Development in Natural Resources Management." Impetus to this publication has been given by the continuous support of SEARCA to its alumni and in harnessing the capacity of individuals and institutions as effective catalysts of agricultural and rural development in the region.

The book is a timely publication of RSAA as SEARCA enters its eleventh Five Year Plan that banners **Accelerating Transformation Through Agricultural Innovation or ATTAIN.** The authors' contribution to realizing sustainable development through research that impacts people's lives aligns well with the center's priority area on sustainable farming systems and natural resources management.

GLENN B. GREGORIO
Director, SEARCA

Preface

This book, *Methodologies Supportive of Sustainable Development in Agriculture and Natural Resources Management: Selected Cases in Southeast Asia,* presents customized methodologies tested by Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) alumni as well as thesis and dissertation grantees in their independent research works. It highlights and celebrates some commendable research and development (R&D) breakthroughs of SEARCA. Thereby, the book is a good reference volume for undergraduate and graduate students and essential for Southeast Asian university researchers and scientists, local government units, and nongovernment organizations concerned with available materials on theory, practice, and R&D for evidence-based decision making. It showcases the impact of SEARCA's graduate scholarship program to Southeast Asia.

I am thankful foremost to SEARCA for the funding of the book through the kind endorsement of Dr. Josefina T. Dizon, Professor of the College of Public Affairs and Development, University of the Philippines Los Baños (UPLB), who is also the President of the Regional SEARCA Alumni Association. The constant encouragement of Dr. Maria Cristeta N. Cuaresma, Head of the SEARCA Education and Collective Learning Department, is also gratefully acknowledged. SEARCA Program Specialist Ms. Zacyl R. Jalotjot was guiding me all the way from accounting to reporting.

I thank all the authors for their perseverance, the technical and language reviewers for their expertise and diplomatic criticism. I commend the SEARCA staff who collated the documents, including the book layout, for the patience. Finally, I thank the Plant Systematics Laboratory, Institute of Biological Sciences, UPLB for the office facilities and equipment, providing and enhancing an ideal environment for work.

INOCENCIO E. BUOT, JR.
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and

University of the Philippines Los Baños

2020

CHAPTER 7

Kopyor Coconut Research and Development Management: From Laboratory Methods to Publishing, Community Extension, and Commercialization

Sukendah[1]

ABSTRACT

There is a need to reexamine the methodologies, activities and procedures of research and development (R&D) especially to determine their impacts on national economic development. In this chapter, I describe how *kopyor* coconut R&D was built in the span of 20 years starting from the laboratory to the community, and the market. *Kopyor* coconut is the Indonesian equivalent of the *makapuno* of the Philippines, resulting from normal coconut mutation expressed in the endosperm. Research on *kopyor* coconut was established based on the roadmap that was started in 2002 by the identification of the *kopyor* coconut germplasm in a farmer's field in East Java. Then, the series of protocols of embryo culture were done after enough materials were collected from several germplasm sites. In 2005, after completing the embryo culture protocol, the somatic embryogenesis experiments and exploration of the genes that controlled *kopyor* traits were begun. In 2010, the outputs of researches, i.e., embryo culture and zero waste technology, were started and introduced to the coconut community. Later, the zero waste technology of *kopyor* coconut was developed for five years to produce heterozygous and homozygous *kopyor* seedlings and some products, such as the following: frozen meat, ice cream, cocktail, *nata de kopyor* , biovet fertilizer, and liquid smoke. In 2018, two *kopyor* products were prepared for commercialization—heterozygous seedlings and frozen meat—supported by the Ministry of Research, Technology and Higher Education. *Kopyor* coconut R&D produced six kinds of products (*in vitro* seedling, heterokopyor /heterozygous seedling, meat de copyor frozen meat, ice cream, nata de kopyor, and biovet/biofertilizer). Eight patents of *kopyor* technologies, equivalent to publications also resulted from the *kopyor* R&D. But besides the patent, the *kopyor* researchers have gone and assisted the communities and networked with them to hopefully contribute to their economic and village development. Three products (seedling, frozen meat, and ice cream) have been produced and marketed in the villages.

Keywords: *kopyor* coconut, commercialization, coconut technology, research and development, R&D, zero waste technology

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INTRODUCTION

In the last decades, the academic scientists were not only expected to teach but also do research and development (R&D) that have an economic impact on society. It has been known that most academic scientists focused on exploring science and technology but lacked attention on how people could be applying the knowledge gained. Many research results are good for publication in journals or books, but not commercially viable because they have not been developed into products and services that are useful for the industry or the community. The results of researches at several universities in America revealed that out of 100 research ideas, only 10 tertiary institutions continued on with research into product development; and of the 10 R&D projects, only two were truly profitable. Half of the universities' R&D funds in the US and Britain are used to finance research projects; however, results are not transformed into products and therefore have never been marketed. This means that the technology developed does not provide commercial value to its innovators (Nasution, Juanda, and Rachman 2009).

It is time for commercialization of research results to be carried out. What steps should be taken by researchers? It depends on how we define the commercialization of research itself. Several authors have defined "commercialization" of research as "transferring theoretical knowledge into several economic activities" (products and services) in academic and research institutions (Spilling 2004; Downie 2006); or a procedure through which research ideas and findings are developed and sold in the form of new technologies, goods, and services involving government laboratories, universities, intermediary organizations, and the private sector (Isabelle 2007). Thus guided, this chapter presents how *kopyor* coconut research in Indonesia has been managed from laboratory on to the community and on to the market through product development.

Kopyor coconut is known as mutated coconut (Samonte et al. 1989). It is characterized by the genetically broken endosperm (or *kopyor* meat) in small pieces and spread into all of the cavity of the coconut shell. The trait for the formation of the *kopyor* endosperm is carried by the recessive gene, the kk genotype, described as homozygous *kopyor* coconut. The *kopyor* endosperm does not appear in the Kk genotype as well as in the KK genotype (described as normal coconut). The kk genotype produces only *kopyor* coconut, the Kk genotype produces *kopyor* and normal coconut, while the KK genotype produces only normal coconut. In the field, only the Kk genotype or heterozygous *kopyor* coconut can be found. Usually, farmers develop this type by planting the normal seed nut from heterozygous *kopyor* coconut, assuming that this seed nut carries the *kopyor* gene. The homozygous *kopyor* coconut is lethal since the broken endosperm as a source of nutrient for embryo germination. The development of the homozygous *kopyor* coconut seedling can be done by embryo rescue technique through in vitro culture.

The main problem in developing *kopyor* products is the limited materials. In Indonesia, as *kopyor* coconut is very rare and can only be found in Java island and in Lampung (Sumatera). The population is scattered in Sumenep, Jember (East Java), and Pati (Central Java). Collecting materials from those sites needs much time and budget. However, *kopyor* is a specific coconut mutant and has a high economic value. Realizing the value of *kopyor*, the dean of the Faculty of Agriculture of the Universitas Pembangunan Nasional (UPN) Veteran Jawa Timur established the *kopyor* R&D team and gave funding to start the exploration of *kopyor* germplasm in East Java. To develop the *kopyor* seedling, the Faculty provided a biotechnology laboratory. Since then, *kopyor* R&D has been done step-by-step based on the roadmap, with all research budget coming from the Indonesian government through a competition research grant. Thus, this chapter aims at (a) describing the process of the establishment of the *kopyor* research from laboratory to the field, and (b) describing how *kopyor* products were developed for commercial purposes.

METHODOLOGY

Study Site and Materials

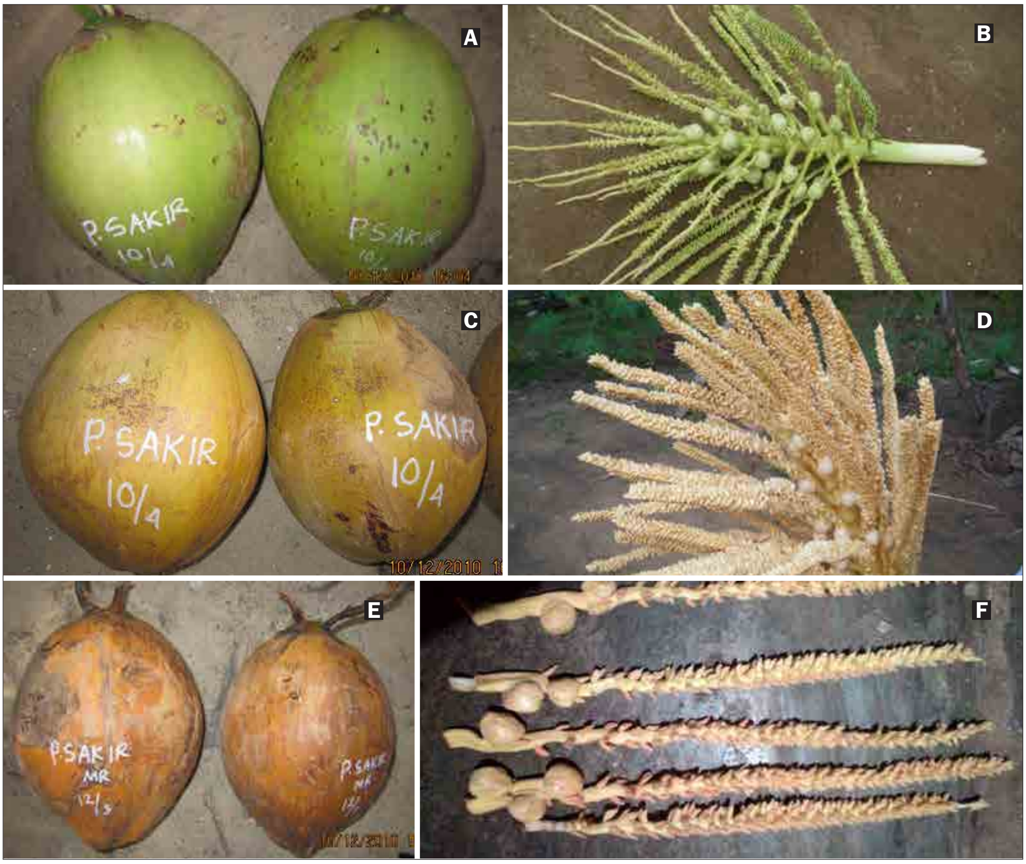
The first step was the identification of the center of *kopyor* coconut population to serve as study site and source of research materials. These sites were in East Java (Sumenep and Jember) and Central Java (Pati). In Sumenep, the population of *kopyor* coconut was composed of only tall *kopyor* coconut. In Jember, tall and dwarf *kopyor* coconuts were found, while tall, dwarf, and hybrid *kopyor* coconuts were found in Pati. Based on the color of the fruit and inflorescence, there were green, brown, red and yellow *kopyor* coconuts (Figure 7.1). The materials for this research, i.e., dwarf and tall types with green, brown, red and yellow fruits, were taken from the three sites mentioned. Figure 7.2 shows the materials of *kopyor* coconut embryos used for developing in vitro seedlings, and endosperms of *kopyor* coconut as materials for frozen meat and ice cream.

The R&D program was designed as a roadmap for 18 years, from 2002 to 2020 (Figure 7.3). This roadmap became a guide for *kopyor* R&D activities in each stage within a certain period of time, based on the achievements in each stage. According to the roadmap, the *kopyor* program is divided into five periods, as described below.

Period I: Laboratory Work

This period covered 2002 to 2011, with the research program focused on (1) developing laboratory protocol for embryo culture and somatic embryogenesis methods, (2) identification of genes that control the *kopyor* trait, and (3) development of zero waste technology.

Figure 7.1. Materials of *kopyor* coconut based on the color of fruit and inflorescence



Note: (A, B) green; (C, D) brown; and (E, F) red

Figure 7.2. Embryo (A) and (B) endosperm of *kopyor* coconut

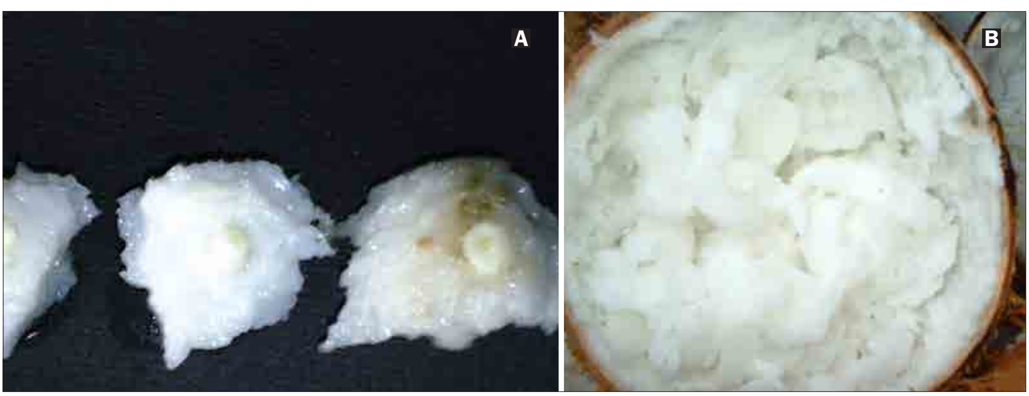


Figure 7.3. Roadmap of *kopyor* coconut research and development (2002 to 2020)

	Laboratory						Community			Scaling-up		Standardization		Market
	2002-2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018-2020
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Research Topics	- In vitro conservation for germplasm exchange - Potency *kopyor* coconut in East Java	In vitro propagation of *kopyor* coconut through zygotic and somatic embryo culture			In vitro propagation of *kopyor* coconut with cleavage of apical meristem		Increasing percentage of *kopyor* coconut fruits through breeding program and molecular markers			Protocol of somatic embryo with immersion dehydration from plumule explant and zygotic embryo without haustorium		Creating *kopyor* coconut seedling through clean technology		Standardization and certification on products derived from *kopyor* coconut
				Isolation and sequencing of *kopyor* gene	Somatic embryogenesis and molecular analysis	Technology of *kopyor* coconut for nursery and secondary products		Implementation of zero waste technology base on *kopyor* coconut						
Source of Funding	- Higher Education of RI	Higher Education of Republic Indonesia		Sandwich programme	Higher Education of Republic Indonesia		Agriculture Ministry			Higher Education of the Republic Indonesia		Ministry of research, technology and higher education		Ministry of research, technology and higher education
	- UPN Veteran Jawa Timur				Doctoral grant	Hi-Link (Higher Education of the Republic of Indonesia)		Higher Education of the Republic of Indonesia						
Outputs	- Protocol of germplasm conservation - Germplasm of *kopyor* coconut in East Java	-Technique of zygotic embryo -Zygotic *kopyor* seedling		-Sequence of alpha D galactosidase of *kopyor* coconut -Primer of genes related to *kopyor* trait - Patent: Method of clonal propagation of *kopyor* coconut through somatic embryogenesis	- Method of splicing apical meristem culture - Method of somatic embryogenesis - Patent: Early Detection of *kopyor* coconut using specific marker of alpha-D-galactosidase gene	Composition nutrition of endosperm and coconut water of *kopyor* coconut	- Method for controlling pollination of *kopyor* coconut - Hybrid heterozygous *kopyor* coconut seedling -Patent: Method of explant excision of Zygotic embryo for propagation of dwarf *kopyor* coconut	-Method for endosperm preservation - Patent: Formulation of *kopyor* coconut media		- Design: Bioreactor of moving dehydration soaking - Patent: Method of molecular marker of sucrose synthase gene on *kopyor* coconut		-Design: Automatic tier shaker -Patent: Process of natural reservation and frozen storage of *kopyor* coconut	-Trademark: Biovet -Patent:Formulation of ice cream of *kopyor* coconut	-HACCP certificate for frozen meat of *kopyor* coconut -Trademark:Hetero-*Kopyor* -Trademark Meat de *Kopyor* -Design: Plant seedling box with knockdown system -Patent: Method of creating hetero-*kopyor* seedling by seed control

Production of *kopyor* coconut seedling and its derivat

Period II: Transfer of Complete Kopyor *Technology to the Community*

In 2010 to 2014, the complete technology of *kopyor* production was relayed to the community in the form of extension education programs.

Period III: Scaling Up Production of Kopyor *Products*

This period that started in 2015 covered scaling up the production of *kopyor* products on the home industry scale, and improvement of the final technology that fits with the business environment.

Period IV: Standardization and Certification of Products

Standardization was started in 2017 for the production of *kopyor* products with hazard analysis and critical control points (HACCP). In 2018, a halal certification was proposed for frozen coconut meat, which was eventually granted in 2019.

Period V: Marketing of Kopyor *Products*

This period started in 2018 with the introduction of *kopyor* products into the market and the launching and commercializing of *kopyor* products in the right time and right place.

RESULTS AND DISCUSSION

Research and Development Planning of *Kopyor* Products

Good research starts with good R&D planning, which produces a roadmap to achieve its goals at specified times. It helps to organize and map out the entire R&D process and provide a path for accomplishing the intervening goals. For the researchers, research planning is a map for their career as research science professionals. It is also a roadmap to demonstrate intellectual vision, aspirations, and creative thinking. According to Burian, Rogerson, and Francis (2010), the R&D roadmap is the framework of the study that addresses both the research process and a number of research options, in a matrix format with columns representing the steps in the process and rows representing elements in the designs. This model allows novice researchers to locate where they are in the process and compare research designs, options for methods, and analysis and interpretation. On the technology side, roadmapping is a flexible technique that is widely used within industry to support strategic and long-range planning. The approach provides a structured (and often graphical) means for exploring and communicating the relationships between evolving and developing markets, products, and technologies over time (Phaal, Farrukh, and Probert 2004).

The *kopyor* R&D Roadmap was planned for the duration of 2002 to 2020, and consisted of three main parts, namely: the topic of research, funding, and output research (Figure 7.3). It was designed to combine science and technology with the market in the production of homozygous and heterozygous *kopyor* seedlings and the derivative products. The roadmap started with basic science of *kopyor* coconut, i.e., all the information needed for producing *kopyor* coconut in Indonesia. In 2002, very few research studies had been done on *kopyor* coconut. Thus, it was very important to find the population center of *kopyor* coconut, including all the types of *kopyor* coconut in Java Island, to build the rare row materials and the distribution patterns of *kopyor* coconut fruits/seeds. In 2006–2009, it was time to develop its own protocol of embryo culture and identify the gene that controls the *kopyor* traits, as production of *kopyor* seedlings in laboratory scale was started. However, the production of seedlings resulted in organic waste such as endosperm, coconut water, coconut fiber, and coconut shell. Since 2010, a clean technology was developed to process organic waste, which became secondary/side products with high added economic values.

Once the *kopyor* technology, including the clean technology system, was ready, it was disseminated to the coconut farmers who had been partners in the supply of raw materials of *kopyor* fruits. In addition, we knew that the purpose of academic research was to produce knowledge and solutions for the benefit of all. Results must be easily exploitable rather than just remaining in the hands of a small academic community. Besides, the *kopyor* technology needed to be adapted easily to the local environment. Thus, in 2010–2011, the *kopyor* technology was applied in one of the *kopyor* centers in Sumenep Regency, East Java.

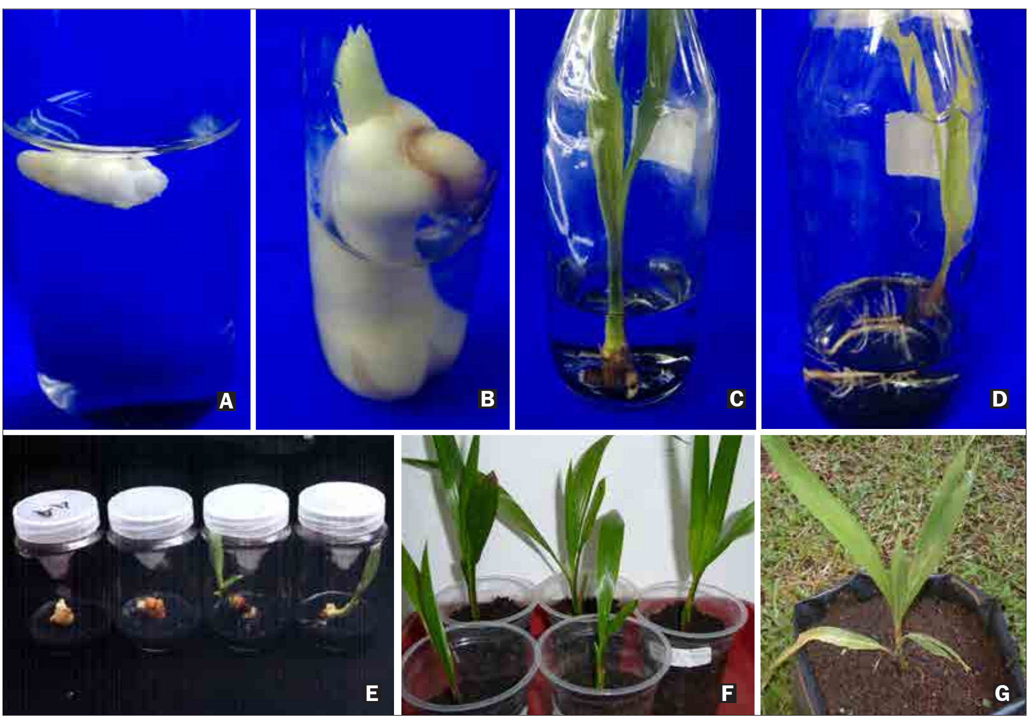
However, the transfer of production technology was not enough just for extension education initiatives. It would be more useful for both the university and the community if the results of *kopyor* research could be commercialized. Therefore, starting in 2017, the research program focused on the standardization process, certification (HACCP and halal), and scaling up of the production. Products that had high commercial value were registered for intellectual property rights (IPR) such as patents, designs, and trademarks before being marketed. While waiting for the standardization process to be completed, in 2018, the program was carried out to establish a technology-based startup company, in partnership with tenants, who would market *kopyor* products.

Based on the experience with R&D planning of *kopyor* as described above, the establishment of a holistic, integrated R&D plan that fits the needs of universities, communities and markets cannot be done at once. R&D planning needs to be done in stages with each stage interconnected with other stages. Research planning is just like setting up a ladder, where the first step is the basis for moving on to the next and higher step. Sometimes, before one goes to the next step, the researcher must go to the field to observe or get practical experience of what the community or market needs. This is necessary to get feedback for the continuous improvement of the product as well as the R&D planning itself. Based on practical experience, usually, there is a gap between the research planning that has been made and what the community needs.

Developing *Kopyor* Coconut Technology

Initially, the main goal of the *kopyor* coconut R&D was to create a homozygous *kopyor* seedling. The laboratory protocol to produce homozygous seedling through in vitro culture (embryo culture) can be achieved with a series of sterilization steps, embryo-cultured media, and acclimatization. Figure 7.4 shows the process of homozygous *kopyor* production used in the laboratory protocol of UPN Veteran Jawa Timur. It is very important to develop one's own protocol, especially for laboratory research. Often, the method for a particular result, as described in a journal publication, does not give the same results if applied in other laboratories, maybe because of the use of

Figure 7.4. Process of production of homozygous *kopyor* coconut



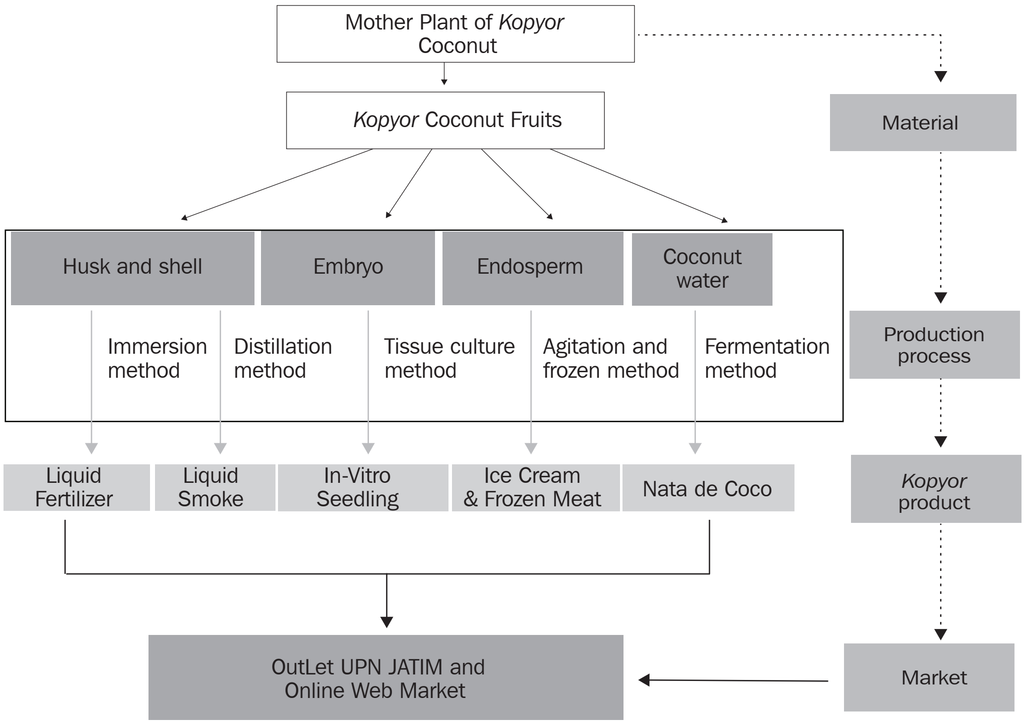
Note: : (A) cultured embryo in liquid media; (B) germinated embryo; (C) plantlet; (D) rooted plantlet; (E) embryo-plantlet cultured in the solid media; (F) acclimatization; and (G) kopyor coconut seedling planted on the ground different materials, sets of equipment, and the laboratory environment. The method needs to be modified and adapted in the particular laboratory. The modification of the existing method can be considered as an innovation step. The technology of this modification can be claimed as new and may be registered under IPR. Some of the *in vitro* culture technologies of *kopyor* coconut (Table 7.1) have been registered under the patenting right.

The process of producing *kopyor* seedling resulted in wastes or by-products such as coconut water, endosperm, shell, and husk. To make economic use of the organic waste, a zero waste technology was developed. Figure 7.5 shows the process of zero waste technology of *kopyor* where all the parts of the coconut fruits are processed. The embryo produced homozygous seedlings. The processed endosperm became ice cream and frozen meat while the coconut water was successfully processed into *nata de coco*. Meanwhile, the processed coconut husk and shell became liquid fertilizer or liquid smoke.

Table 7.1. List of *kopyor* coconut intellectual property rights

No.	Title	Year	Type of IPR	Registration Number/ID
1.	Clonal Propagation Method of *Kopyor* Coconut through Somatic Embryogenesis	2008	Patent	ID P0030771
2.	Early Detection of *Kopyor* coconut Using Molecular Markers of Specific Alpha-D Galactosidase Genes	2009	Patent	IDP000042673
3.	Methods of Cleavage of Zygotic Embryos Explants for Reproduction of *Kopyor* Dwarf Coconut Seedling	2010	Patent	P00201000746
4.	Culture Media for Germination of Zigotic Embryos of *Kopyor* Coconut	2013	Patent	P00201304458
5.	Development Method of Molecular Markers of Sucrose Synthase Genes on *Kopyor* Coconut	2014	Patent	P00201402087
6.	Automatic shaker	2016	Design	A00201600641/ IDD0000046144
7.	Natural Preservation Process and Frozen Storage of *Kopyor* Coconut Meat	2016	Patent	P00201606031
8.	Formulation Method of *Kopyor* Coconut Ice Cream	2017	Patent	S00201706106
9.	Biovet	2017	Trademark	D00201703972
10.	Method of Assembly of Heterozygous *Kopyor* Coconut Seedling with Seed and Seedlings Control Techniques	2018	Patent	PID201811294
11.	Nursery box knock down system	2018	Design	AID201801456
12.	Heterokopyor	2018	Trademark	DID 2018026623
13.	Meat De Copyor	2018	Trademark	DID2018026622

Figure 7.5. The system of zero waste technology of *kopyor* coconut



Zero waste technology in *kopyor* is a set of methods used to process and recycle all parts of *kopyor* materials back into processing for marketable products. In this concept, methodologies are devised in such a manner that there are no by-products or wastes formed during processing. Even if waste is produced, it can be used as raw material of another *kopyor* processing unit. In a normal coconut, almost all the parts are processed as main products or by-products. Ghosh (2015) mentioned that all parts of the coconut are useful both for domestic and industrial purposes, thus, it is called "nature's supermarket." Some by-products of a normal coconut are coconut fiber (e.g., coir and coir products, mats, matting, brushes, brooms, and rubberized coir mattresses) and shell products (e.g., charcoal, activated carbon, etc.). Zero waste technology has been used in *Jatropa curcas* and dandelion. Different parts of Jatropha have been processed into medicinal products such as antibiotics, medicine for skin diseases, and others; it was called "the zero-waste use of Jatropha" (Chhetri et al. 2006). What is important is that the zero waste technology of *kopyor* will reduce cost of production of *in vitro* seedling as its main product and will minimize losses by opening opportunities in product diversification from only one production input.

Transferring the zero waste technology to the coconut community by an extension education program was done to establish partnerships in the production of homozygous *kopyor* seedlings. The laboratory only required the embryos. The endosperm, water, and shells could be processed by farmers into products that were ready for sale. This program can be categorized as a research dissemination. Wilson et al. (2010) defined "research dissemination" as a planned process that involves consideration of target audiences and the settings, in that research findings are to be received; and, where appropriate, communicating and interacting with wider policy and health service audiences in ways that will facilitate research uptake in decision-making processes and practice.

Producing by-products of *kopyor* coconut with zero waste technology is easily adaptable and implemented by farmers because it does not require expensive investments. In contrast, *in vitro* seedling production requires laboratories, expensive equipment and skills that may not be easily available from farmers. In this case, the partnership between the laboratory and the coconut farmer community is very important to get a mutually beneficial relationship. Although the farmers in the community know the commercial value of *kopyor*, they sell *kopyor* products only in fruit form. They do not have the knowledge and expertise to produce diversified *kopyor* products. Therefore, zero waste technology training program is needed to increase the farmer's income through their *kopyor* diversification products.

The keys to the success of the research extension program include the following: (1) zero waste technology of *kopyor* was disseminated to groups who needed this technology to increase the value of the farmers' product; (2) the methods used in the extension education program involved pioneers who acted as farmer-teachers for the group; and (3) maintenance of sustainable relationships between the university and coconut farmer community. For example, training programs were not only done at the coconut farmer's place but coconut farmer community members were also invited to trainings on campus. This brought the relationship between campus and coconut community closer. Figure 7.6 presents the activities of the *kopyor* training program to disseminate zero waste technology, both done onsite (done in the community place) and outside (done in UPN Veteran Jawa Timur Laboratory).

Publication and Commercialization of *Kopyor* Coconut R&D Outputs

Commercialization of research findings often creates a conflict between stopping after publishing the research results in a technical journal, and going on to develop products, as well as commercializing them. Svensson (2008) said that publishing the research results means making the results available to all. In a commercialization process, the aim is to keep the knowledge discovery a secret for as long as possible. This means that one should not publish a pertinent paper before the patent application has been submitted and approved. If the results have already been published, the patent will not be approved. Therefore, the results of *kopyor* R&D were immediately submitted for IPR such as patents, designs, and trademarks before publication.

Figure 7.6. Training for the coconut community and implementing the zero waste technology supervised by the UPN Veteran team of *kopyor*

Notes: (A) R&D team with the coconut community in the kopyor plantation; (B) training in making by-products of *kopyor*; (C) transfer of knowledge through lessons conducted in class; (D) training in embryo isolation and sterilization; and (E) training in embryo culture in the laboratory.

For *kopyor*, there are now 5 patents and 2 designs for homozygous *kopyor* seedlings; 1 patent, 1 design, and 1 trademark for heterozygous seedlings; 1 patent and 1 trademark for frozen meat; 1 patent for ice cream; and 1 trademark for liquid fertilizer.

Commercialization of research outputs of *kopyor* coconut was carried out in three steps: (1) identify the *kopyor* product that has high marketable value and ensure that the product has been protected by IPR before marketing it, (2) scale up the production of chosen products, and (3) standardize and certify the products. Despite the many *kopyor* products being developed, only two had been chosen for commercialization, i.e., heterozygous *kopyor* seedling and the frozen *kopyor* meat. Other products still have a number of technological or market barriers.

Scaling up the products of *kopyor* from the small-scale laboratory experiments required prototype improvement and business activities to adapt the products and their technologies to a true environment market. Conversion of the prototypes into commercial products usually needs active participation of the researchers/inventors. Jensen and Thursby (2001) showed that 71 percent of the commercialized inventions required participation of researchers. This is because the researchers often have specific technical knowledge details about the inventions that cannot be codified and that are needed when adapting the innovations to the needs of the market (Svensson 2008).

In the case of *kopyor*, two products, i.e., heterozygous seedling and frozen meat, have received funding for commercialization from the Indonesian government. This budget will be spent to complete the product prototyping and to produce such products for the market.

Recently, standardization and certification of products have become important issues that should be considered seriously since the problems of quality assurance and food security continue to present themselves in accordance with the demands and requirements of consumers and human welfare. In addition, from the point of view of business, standardization, and certification of products are socially beneficial, which may enhance product demands. The products labelled as “halal” boosts people’s trust on the safety of food for consumption.

CONCLUSION AND RECOMMENDATION

R&D management is the arrangement of research work from upstream to downstream. It starts with creating a research roadmap, implementing research activities, then registering the research results under IPR, followed by publishing the research results, transferring the knowledge and technologies to the community, and ending up with commercializing the products. The *kopyor* coconut R&D program produced 8

Figure 7.7. Product derivatives of *kopyor* coconut

Notes: (A) Heterokopyor (heterozygous kopyor seedling); (B) coco water; (C) meat de copyor (frozen meat of *kopyor* coconut); (D) *kopser* (*kopyor* ice cream); (E) meat de coco (*nata de coco*); and (F) Biovet (liquid fertilizer)

patents, 3 designs, and 3 trademarks. The heterozygous *kopyor* seedling and frozen meat are still undergoing commercialization activities funded by the Indonesian government.

The development of technologies and products of *kopyor*, transferring them to the commercialization phase, and bringing them to the market, involved a long process that needed intensive engagement of research teams, university policies, and government support. A good roadmap or research planning as guidance for the research team was needed to achieve the goal. The commercialization of products of *kopyor* consisted of three steps: (a) identification of marketable products, (b) scaling up, and (c) processing the standardization and product certification.

The research showed that the use of different methods in the transfer and commercialization of technologies and products yielded different research results. The success of implementing research in the community and market studies depends on infrastructural availability, university policy, government support, and research team commitment and engagement.

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