STUDY AND DEVELOPMENT OF PRODUCTS FROM AGRICULTURAL WASTE MATERIALS OF THE BAN HOM THONG BANANA COMMUNITY ENTERPRISE, BAN KHOK, SANG KHOM DISTRICT, UDON THANI PROVINCE

Rosjana Chandhasa
Faculty of Engineering and Industrial Technology, Suan Sunandha Rajabhat University, Thailand
E-mail: rosjana.ch@ssru.ac.th
Panu Pattanapanithipong
Faculty of Engineering and Industrial Technology, Suan Sunandha Rajabhat University, Thailand
E-mail: panu.pa@ssru.ac.th
Chutima Ngampipat
Product Packaging Design Program, Faculty of Engineering and Industrial Technology, Suan Sunandha Rajabhat University, Thailand
E-mail:chutima.ng.@ssru.ac.th

Abstract

This research aims to study and develop products from agricultural waste materials of the Ban Hom Thong Banana Community Enterprise in Ban Khok, Sang Khom District, Udon Thani Province. A mixed-methods approach was employed, integrating qualitative and quantitative research methods to examine community context, consumer needs, and product design potential. Qualitative data were collected through fieldwork, structured interviews, in-depth interviews, and group interviews, and analyzed using descriptive analysis. Quantitative data were obtained from product evaluation questionnaires administered to three product design experts and a purposive sample of 100 consumers selected from tourists and shoppers at the community enterprise. The results indicated that knowledge of materials, design processes, and community identity could be effectively applied to product development. A sketch design was created and used to develop one prototype product. The evaluation results showed that consumers' opinions toward the lifestyle product made from agricultural waste materials were at a good to very good level. Respondents perceived that the product enhanced the value of agricultural waste, clearly reflected community identity, and demonstrated potential for commercial development. The developed product contributes to value addition, enhances the competitiveness of the community enterprise, and supports sustainable grassroots economic development.

Keywords: Agricultural Waste, Ban Khok Golden Banana,Natural Materials

Introduction

Bananas are an important economic crop; their fruit is sold both domestically and internationally. Naturally, all banana plants produce fruit only once. After fruiting, the trunk is cut down and discarded, leaving the trunk unused. Therefore, banana stalks are often used as fertilizer in plantations (Rung Pink ham, 2014). This study investigated the utilization of banana stalk fibers to add value to these discarded plants. The resulting textile products are then used in clothing design. This innovation in lifestyle products from processed banana waste is developed based on the needs of target groups and stakeholders—producers and consumers—in line with the new normal lifestyle. The goal is to create a commercially

competitive lifestyle product that increases the value of the banana processing group's products under the BCG (Bio-Circular-Green) model. This leads to increased sales and a 10% increase in income for the group. Subsequently, the acquired knowledge is extracted , and the technology transferred through participatory processes to target groups and stakeholders in the area and surrounding regions, enabling them to enhance their competitiveness, increase income, and achieve sustainable self-reliance.

Upon Than Province has a vision to be "the center of economic development, identity-based tourism, and environmentally friendly safe agriculture in the Greater Mekong Subregion." It supports the economy, agricultural production, food and services, and agricultural product transportation, focusing on key agricultural products of the region. This aligns with identity-based tourism related to civilization and history, linking with the culture, traditions, and way of life of local communities. The goal is to empower communities in sustainable management, distribute income, strengthen communities, and increase the efficiency of agricultural production, industry, and related services, particularly fruits and vegetables, which form the production base of the provinces. This involves increasing the value of production throughout the supply chain, promoting continuous growth, supporting the use of technology and innovation to drive economic growth, create job opportunities, and ensure income security for local residents while reducing labor migration to the capital and other regions. The Ban Kook Golden Banana Community Enterprise Group in Sang Whom District, Upon Than Province, is a leading network in the area with significant potential in the production and sale of golden bananas, particularly those grown in the region.

The innovation of lifestyle products focuses on leveraging local intellectual capital and bio-resources, particularly fibers from various parts of the banana plant, including banana leaves, banana sheaths, and banana fibers. These are applied in processing, fiber production, and dyeing to develop high-quality and unique lifestyle products. The project integrates design knowledge with local cultural wisdom to address regional problems, enhance the potential of entrepreneurs and communities, create unique selling points, increase competitiveness, and stimulate sustainable community economic growth.

Research Objectives

1. To study the transformation of banana waste from processed Cavendish bananas in Ban Kook, Sang Whom District, Upon Than Province into lifestyle products.
2. To study the design and development process of innovative lifestyle products from processed banana waste from Ban Kook, Sang Whom District, Upon Than Province.

Scope of the Research

1. Scope of Research

This research, "A Study and Development of Products from Agricultural Waste Materials of the Ban Khok Banana Community Enterprise Group, Saeng Khom District, Udon Thani Province," has the following scope:

1.1 Population Scope

The research population consists of Three product design experts to evaluate the design and quality of the products. 100 consumers selected using purposive sampling from tourists and shoppers of the Ban Khok Banana Community Enterprise Group, Saeng Khom District, Udon Thani Province.

1.2 Variable Scope

The variables used in this research include Independent variable: The design and development of products from agricultural waste materials, utilizing knowledge of materials, design processes, and community identity.

Dependent variable: The level of opinion and satisfaction of experts and consumers regarding the product in terms of design, usability, value, and commercial potential.

Literature Review

The Cavendish banana, also known locally as "Golden Cavendish Banana" or "Banana," has the English name Grow Michel and the scientific name Must (AAA group), belonging to the family Rutaceae. It is a herbaceous plant with a pseudostem, reaching a height of 2.5-3.5 meters and a diameter of 20 centimeters. The outer sheath of the stem has black spots, while the inner sheath is light green with pink stripes, a distinguishing feature of this banana variety. The leaves and petioles have relatively wide grooves and wings, and the midrib is green. After 9–10 months, the banana plant begins to produce fruit, after which it ceases production and is cut down to be used as fertilizer or animal feed (Sujit Muangsook, 2020)

Bananas thrive in hot and humid climates, making them well-suited for cultivation in Thailand. If temperatures fall below 14 degrees Celsius, banana growth will be stunted or significantly slowed, and flowering and fruiting will be delayed. Furthermore, bananas have large leaves, making them less resistant to wind. The leaves can easily break due to wind resistance. Excessive leaf breakage can reduce photosynthesis, hindering plant growth. Therefore, in windy areas, other trees should be planted as windbreaks to protect the banana plants. The ideal soil for banana cultivation is alluvial soil, locally known as "flowing water and sandy loam," a fertile, well-drained, and aerated loam. If the soil is clayey, adding manure will improve its porosity (Benjamas Silayoi, 2005).

Research Methodology

This research focuses on developing products from agricultural waste materials for the Ban Khok Golden Banana Community Enterprise Group in Saeng Khom District, Udon Thani Province. It employs a mixed methods research approach, combining qualitative and quantitative research to study community identity, material potential, consumer demand, and evaluate product design. The researcher has defined the research steps and methodologies as follows

1. Qualitative Research This research involved collecting data from documents, books, research papers, and articles related to community identity, local wisdom, bioeconomy, circular economy, and product design from agricultural waste. This was combined with fieldwork at the Ban Khok Golden Banana Community Enterprise in Udon Thani Province to study the physical characteristics of the banana plant, its fibers, and production processes. In-depth interviews and focus group discussions were conducted with design experts and stakeholders to analyze and synthesize the data into concepts for prototype product design.

2. Quantitative Research The population and sample consisted of three design experts and 100 consumers/tourists, selected using simple random sampling. The tools used were a product needs questionnaire and a prototype product design evaluation form. The data were analyzed using basic statistics, including percentages, means, and standard deviations, to improve and develop the product prototypes.

Research Results

1. Study Results on Processing Banana Waste from Agricultural Waste in Ban Khok, into Lifestyle Products This research, "A Study on the Development of Products from Agricultural Waste Materials of the Ban Khok Banana Community Enterprise Group, Saeng Khom District, Udon Thani Province," utilized a quantitative research methodology. The research process involved the following steps:

1.1 Gathering preliminary research data, including documents, textbooks, books, related research, academic articles, and research papers. Data was also collected on the community, focusing on ecological economics, bioeconomy, circular economy, environmental friendliness, natural resources, the environment, local wisdom, community history, traditional knowledge in production, occupations, handicrafts, and products made from processed banana waste.

1.2 Community Identity: The Ban Khok Golden Banana Community Enterprise Group in Saeng Khom District, Udon Thani Province, is a successful agricultural group that emphasizes market-driven production and operates as a large-scale banana plantation.

1.3 Study of the Physical Characteristics of Banana Plants: Banana plants of similar size were selected for study. Their physical characteristics included general features, the number of layers and length of banana sheaths, the diameter of the banana stem, and the length of the banana stem. The characteristics of banana fiber, the amount of fiber obtained from the banana sheath, and the length of the fiber were also studied.

Figure 1 Agricultural waste materials from processed Cavendish bananas.
Source: Chandhasa, R., Pattanapanithipong, P. &Ngampipat, C.,

2. Results of the Study on the Design and Development Process of Lifestyle Products from Processed Banana Waste in Agricultural Materials

The study found that the design and development process of lifestyle products from processed banana waste in agricultural materials can be systematically linked from the initial concept to the design and development of a product prototype. The key steps are as follows:

2.1 Preliminary Data Collection This study examines relevant documents, textbooks, research papers, and academic articles, as well as gathering contextual information on the Ban Khok community regarding natural resources, the environment, local wisdom, history, and occupational patterns. Emphasis is placed on the concepts of eco-economy, bioeconomy, circular economy, and environmental friendliness, along with traditional knowledge of banana production, handicrafts, and the utilization of bananas in the community.

2.2 Identity and Product Design Study This research focuses on developing community products that reflect the community's identity. Inspiration from local culture, lifestyle, and resources is applied to designing lifestyle products from processed agricultural waste, specifically bananas, to promote tourism and create unique product innovations for the Ban Khok community, Saeng Khom District, Udon Thani Province.

2.3 Fieldwork and Data Collection Fieldwork was conducted to collect data from a sample group including producers, related entrepreneurs, design experts, marketing experts, and target consumers in the Ban Khok community, Saeng Khom District, Udon Thani Province. This information will be used to inform product design and development.

The study found that the Cavendish banana is a cash crop that has been known and consumed by Thais for a long time. It can be grown in all regions of Thailand and has potential for export development due to its year-round production. This results in a large amount of waste material from the processing, which can be developed into raw materials for creating innovative lifestyle products.

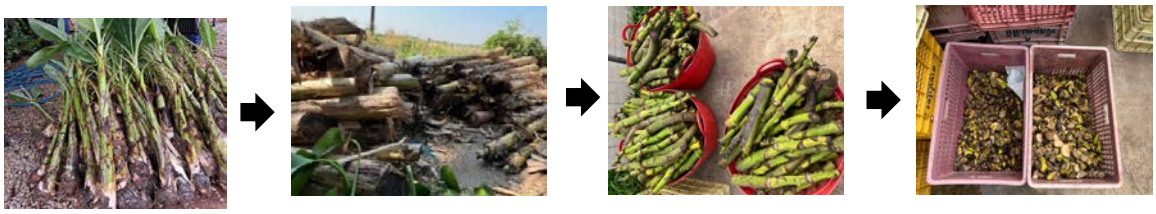

Figure 2 Field trip photos.
Source: Chandhasa, R., Pattanapanithipong, P. &Ngampipat, C.

3. From connecting concepts to design development,the conclusion is that the product to be developed is a pair of shoes. The design approach is modern, unique, and reflects a contemporary style, emphasizing simplicity coupled with practicality and functionality. Furthermore, the product utilizes entirely natural materials that are renewable and environmentally friendly, adding value to the materials and product under the concept of sustainable development.

Product Prototype from Agricultural Waste MaterialsThis product prototype, designed using agricultural waste materials from the Ban Khok Golden Banana Community Enterprise Group in Saeng Khom District, Udon Thani Province, demonstrates the application of the concept of efficient and sustainable resource utilization. The resulting prototype is complete and can be further developed into innovative lifestyle products from processed banana waste from Ban Khok Golden Banana in Saeng Khom District, Udon Thani Province.

Regarding materials, the production and processing methods for banana fibers have been appropriately developed. Banana peels, an agricultural waste material, are processed into fibers. These fibers are then air-dried using gentle sunlight to ensure uniform drying. This results in fibers that are strong, durable, and resistant to mold growth, enhancing their potential for commercial product design and development.

Figure 3 Banana fiber from Ban Khok, Saeng Khom District, Udon Thani Province.
Source: Chandhasa, R., Pattanapanithipong, P. &Ngampipat, C.

Product Design and Development from Agricultural Waste Materials for the Ban Khok Banana Community Enterprise Group, Saeng Khom District, Udon Thani Province.

The researchers collected data using questionnaires from product design experts. The information, suggestions, and opinions were analyzed and synthesized to guide the design concept and direction, aligning with the context of the community enterprise group and the characteristics of the agricultural waste materials used.

The researchers then created product sketches, considering aesthetics, usability, functionality, and material suitability to meet user needs and the community's production potential. These sketches were continuously developed and improved based on expert feedback before being used to create product prototypes. The goal of this project was to produce product prototypes that are suitable in terms of design, usability, and production feasibility, thereby adding value to agricultural waste materials and promoting the development of innovative lifestyle products for the community under the concept of sustainable development.

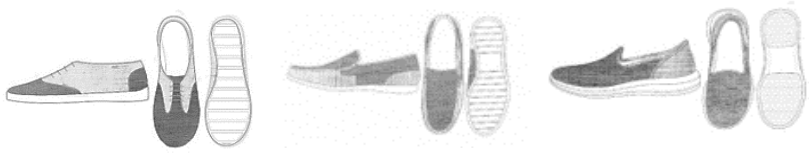

Figure 4 Sketch Design
Source: Chandhasa, R., Pattanapanithipong, P. &Ngampipat, C.

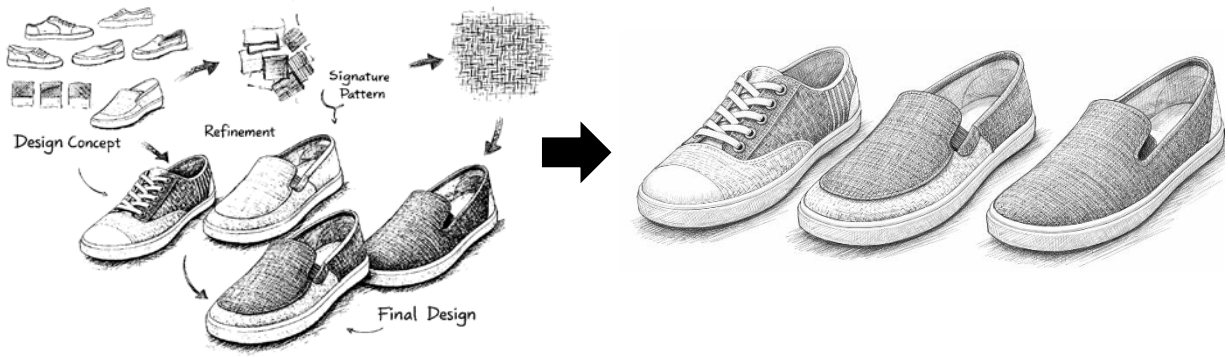

Figure 5 Sketch Design
Source: Chandhasa, R., Pattanapanithipong, P. &Ngampipat, C.

A prototype product utilizing agricultural waste materials from the Ban Khok Banana Community Enterprise Group in Saeng Khom District, Udon Thani Province, was developed by submitting a sketch design to three product design experts for evaluation. This resulted in the selection of one innovative lifestyle product made from processed banana waste. The product was then revised according to the expert recommendations, followed by a final evaluation. The average ($\bar{\mathbf{x}}$), standard deviation (S.D.), and interpretation of the evaluation results regarding the innovative lifestyle product developed from processed b

anana waste by the Ban Khok Banana Community Enterprise Group were then conducted.

Figure 6 Prototype shoes made from agricultural waste materials by the Ban Khok Banana Community Enterprise Group, Saeng Khom District, Udon Thani Province.
Source: Chandhasa, R., Pattanapanithipong, P. &Ngampipat, C.

Table 1: Study on product development from agricultural waste materials of the Ban Khok Golden Banana Community Enterprise Group, Saeng Khom District, Udon Thani Province.

Product prototype	Prototype images of products made from agricultural waste materials	$\bar{x}$	S.D.	level
1.		4.93	0.09	The most
2..		4.93	0.09	The most
3.		4.93	0.09	The most
	Total	**4.93**	**0.09**	**The most**

Discussion

Bananas that have already produced fruit and become waste are processed into banana fibers for use in clothing. The process involves several stages to produce yarn for weaving. This textile product is a green innovation. The clothing reflects the lifestyle and culture of the people of Isan (Northeast Thailand). Green innovation is renewable and does not harm the environment because it is made entirely from natural materials. It adds value to the materials and products. The price of the product depends on the brand and the production process and technology.

Banana fiber textiles have practical uses and functions. The material used in clothing is fabric made from banana fibers. Banana fibers are mixed with cotton fibers to create a new

material, which is then woven into fabric. This adds value to unused banana plants and can replace industrial textile materials in clothing. The entire process, from start to finish, uses natural materials, following the NRU (Nature Returns to Us) concept. This involves utilizing natural materials in a circular economy, maximizing their benefits and ensuring their complete return to nature without environmental impact. However, in terms of fiber development, the fibers are brittle and easily broken, making it difficult to weave them strand by strand. Therefore, when weaving, multiple strands should be used at a time. The fiber surface is white and matte, easily dyed. When woven into fabric, the finished product has a matte finish. The fibers should be tested for their properties to determine their suitability for textile use, such as tensile strength, durability, liquid absorption, and dyeability. In terms of textile development, it was found that in designing patterns, multiple strands should be inserted at a time because the fibers are brittle and easily broken. The patterns used should be adapted and developed from old patterns that are simple yet elegant or have a unique local identity. The sample group participated in brainstorming and provided useful local information, consistent with the concept of developing nipa palm fibers for product design by Janyawan Janyatham and Prathapjai Sikha (2012: abstract), who studied the uses of nipa palms and experimented with developing a process for producing handicrafts from nipa palm fibers. This approach will utilize the unique characteristics of the nipa palm fibers in weaving to create a distinct local product identity and a clear direction for the future. The researchers expect that the knowledge gained from this study on the production of home textiles and products from nipa palm fibers will be available for entrepreneurs and interested parties to study and further develop. It is a home textile product within the handicraft and industrial systems.

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References

Bangkok Post. (2019). *Chap ta mong trend la mareng khong sinkha lifestyle pi 2019* [Keeping an eye on emerging lifestyle product trends in 2019]. https://www.posttoday.com/pr/586695

Eakwutthiwongsa, T. (2019a). *Kan khit choeng anakhot phuea kan okbaep* [Futures thinking for design]. Meen Service Supply.

Eakwutthiwongsa, T. (2019b). *Okbaep phalittaphan utsahakam 1* [Industrial product design 1]. Meen Service Supply.

Muangsook, S. (2020). Banana society: Upgrading traditional dried bananas to a world-class brand with parabolic domes. *Local Technology Journal, 33*(728), 32–34.

Ploysri, W., & Chareonsopa, K. (2024). [Title of the article]. *Journal of Distribution Science, 22*(8), 55–63. https://doi.org/10.15722/jds.22.08.202408.55

Sakorn, C. (2017). *Kan prapprung khunnaphap senyai phuet* [Improving the quality of plant fibers]. Thailand Textile Institute.

Silayoi, B. (n.d.). *Banana varieties of Thailand*. Retrieved August 21, 2023, from http://www.eto.ku.ac.th/neweto/ebook/plant/tree_fruit/banathai.pdf

Suwannin, W. (2020). Guidelines for increasing the value of community products based on sustainable local wisdom: A case study of model communities in Nong Khai Province. *BU Academic Review Journal*, *19*(1), 109–127.