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Prospective analysis of Simantri sustainability: A probability approach

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A B S T R A K

Pemberdayaan petani melalui pelaksanaan Program Simantri adalah salah satu kebijakan pembangunan pertanian daerah Provinsi Bali, yang merupakan sebuah upaya local jangka panjang ke arah kelompok kemandirian pangan, pakan, pupuk organik, energi (biogas) dan kesejahteraan petani. Tujuan penelitian ini untuk menentukan scenario probabilitas keberlanjutan program Simantri dan menentukan sensitivitas scenario pendorong keberlanjutan program Simantri. Penelitian ini dilakukan di Kabupaten Tabanan, Data yang dibutuhkan untuk tujuan tersebut dikumpulkan melalui wawancara menggunakan kuisioner terstruktur, dengan petani Simantri, Pendamping sebanyak 115 responden, serta melakukan Focus Group Discussion (FGD) dengan 19 pakar dana atau stakeholder. Data hasil FGD yang telah dibandingkan/dipertimbangkan dengan hasil dari kuisioner, dianalaisis dengan model SMIC-Prob Expert. Hasil analisis menunjukkan bahwa kombinasi skenario dengan peluang tertinggi adalah pada kombinasi "1101" (cattle, side economi, dan commercial) dengan besarnya peluang yaitu 0.138. Analisis sensitivitas yang diukur dengan elastisitas adalah skenario cattle dan commercial sebagai "prime mover" atau pendorong utama dari sistem. Elastisitas skenario cattle masing-masing 1.677, dan commercial 1.344. Artinya, keberlanjutan program Simantri sangat ditentukan oleh kedua scenario tersebut. Rekomendasi agar program Simantri berkelanjutan yaitu perlu adanya kombinasi skenario "prime over".

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A B S T R A C T

The Simantri program is a long-term regional initiative aimed at the welfare of Bali's farmers as well as self-sufficiency in food, feed, organic fertilizer, energy, and biogas. This study aims to determine the probability scenario and the scenario's sensitivity driving the Simantri program's sustainability. This study was conducted within the Tabanan Regency. The data for this purpose were gathered through interviews with Simantri farmers and 115 respondents as assistants using a structured questionnaire and Focus Group Discussions (FGD) with 19 funding experts or stakeholder groups. The SMIC-Prob Expert model analyzed data from the FGD results compared to or considered alongside the questionnaire results. The results of the analysis indicate that scenario combination "1101" (cattle, economic side, and commercial) has the highest probability, with a probability of 0.138. According to the elasticity-based sensitivity analysis, the cattle and commercial scenario is the "primary mover" or primary driver of the system. With cattle elasticity of 1.677 and a commercial elasticity of 1.344, the Simantri program's sustainability largely depends on these two scenarios. Sustainability recommendations for the Simantri program is "prime over".

INTRODUCTION

Agricultural sustainability is a subfield of sustainable development and is recognized as a promising strategy for agricultural economic stability, particularly concerning the lives of people in developing nations (Bastan *et al*., 2018; Ceotto & Candilo, 2011). However, the effects of policies aimed at ensuring the long-term viability of industrial agriculture may go beyond those of simple farming methods. If incentives are employed on a wider scale, such as a watershed, rather than on a small one, such as individual farms or fields, preserving or improving the environment might be simpler. Furthermore, there is no consensus among professionals and scientists regarding sustainability in agriculture, so it is frequently considered unachievable. Sustainability in agriculture is a complicated, value-laden, context-specific notion (Lichtenwalter & Baker, 2010). How to accomplish numerous incentives or goals can be determined via multimetric optimization. The hardest part of using the optimization strategy is deciding which goals should be optimized because this choice requires choosing views and values. The strategy can aid in choosing incentives for several goals if the goals and constraints utilized in optimization are appropriately specified. But including social goals alongside economic and environmental goals adds another layer of complexity, and any multifunctional study must consider tradeoffs.

Fundamentally, markets and technologies that boost economic viability can also heighten competition for the available agricultural resources (Fischer *et al*., 2011). Increasing competition may result in better agricultural land use, financial incentives for restoration, better underutilized land management, or even violence. So, it's crucial

to include uncertainty in the study and scenarios of agriculture sector activity. Considering how one scenario's sensitivity may affect other situations One or more scenarios may emerge as "prime movers," or the primary factor influencing a system's ability to sustain itself (El Chami & Daccache, 2015; Godet *et al*., 2004).

The Provincial Government of Bali implements the Simantri Program (Integrated Agricultural System) as one of its initiatives to assist farmers in making the most of their property. Through the planned universal development pattern and the strategic vision and mission defined in the regional strategic development program planning policy "Nangun Sat Kerthi Loka Bali," the Simantri program was started and has received the full support of regional authorities (Wibawa & Budiasa, 2018). Based on the potential of each region and the most effective manner to utilize the local resources that are already available, Simantri integrates the operations of the agricultural sector with those of the sectors that support it, both vertically and horizontally. The integrated operations produce 4F and are focused on zero waste farming (food, feed, fertilizer, and fuel).

The Simantri program aims to improve farmer welfare, reduce poverty and unemployment, and integrate it with other initiatives to create a long-term sustainable rural economy. Agriculture, which predominates in rural areas, does not necessitate a high level of employee education. Still, it can help reduce unemployment and poverty and, with the appropriate regulations, balance out workers' wages in the formal sector (Eryanto *et al*., 2023). The Simantri program was established to aid in the development of sustainable agriculture, and its initiatives are anticipated to serve as a prototype for future regional agricultural sector development projects aimed at creating an integrated energy farm system (Anugrah *et al*., 2014). People with various roles and interests will, by their very nature, have varying opinions in the following section of Simantri. People who are simply concerned about one component of sustainability (e.g., environmental sustainability or preventing pollution) might not wish to consider the trade-offs between other aspects (e.g., household welfare or adoption of local culture). While stakeholders who benefit from the status quo may be forced to defer action lest the system change, the inability to make sacrifices rigidifies a situation, which can result in unsustainable outcomes (Dale *et al*., 2013).

According to former Bali Governor Mangku Pastika, the Simantri program's creator, the program's implementation is generally less seamless than anticipated. According to a lot of information from the field, cattle, some half-dead or on the verge of death, is one type of aid (Rhismawati, 2023). Mangku Pastika was prompted to inspect and double-check the Simantri program he had started by going to the field. He even mentioned that a scholar from Oxford University who studied the Simantri Program claimed that Simantri was a *Vedic* agriculture system, i.e., an agricultural system based on the Vedas. This was his main worry and belief regarding Simantri. This gives him more assurance that Bali is an organic and healthy island.

The highest number of Simantri, 150 *Gapoktan* (19.95%) of all Simantri in Bali Province, are in Buleleng Regency, followed by Tabanan Regency with 115 *Gapoktan*, or 15.29%, and Denpasar City with 6 *Gapoktan* (1.06%), according to data from the Agriculture and Food Crops Office of the Province of Bali in 2020. The Catur Angga Batukaru area remains one of the four locations that support the unified Bali Cultural Landscape Subak System that has been developed by UNESCO, despite Tabanan Regency holding the second-highest number of Simantri in Bali Province (Dharmiasih *et al*., 2012; Rahmi & Setiawan, 2020).

At *Gapoktan* in Tabanan Regency, the Tri Hita Karana religious ideology is practiced. One of the Balinese local wisdom principles known as Tri Hita Karana lends meaning to the welfare and prosperity of human life. With aid from the Bali Province Government, *Gapoktan* in Tabanan Regency has adopted agricultural technologies, particularly fertilizer processing. Also, some *Gapoktans* have begun implementing a well-executed integration and cooperation pattern, specifically by making organic fertilizers focused on zero-waste farming and yielding 4F (food, feed, fertilizer, and fuel). The success of the Simantri program has not been attained in Tabanan Regency's *Gapoktan*, where fertilizer distribution is still restricted. In circumstances like this, government intervention is necessary (Darmayasa, 2014).

Simantri as a special program owned by the provincial government of Bali has a big contribution in agricultural development. Simantri's several studies focus on the development of fertilizer products (Sudita *et al*., 2018), cattle feed (Sudita *et al*., 2015), health of bali cattle (Heryani *et al*., 2019; Laksmi *et al*., 2020), and farmer character (Sanjaya, 2018). Many elements of Simantri need to be revealed as an effort to develop an agricultural program. For example, the commercial product-focused Simantri program has largely only been adopted by a small number of *Gapoktans*. In any activity, there will always be an element of uncertainty. Every development element conducts a sustainability analysis of risks and uncertainties. Numerous sustainability studies have been done in several social and environmental sciences sectors. However, the economic effects of social humanities-related activities on the environment have not specifically been the subject of investigation. To increase people's welfare through collaboratively planned activities that consider economic, social, and environmental factors, the Balinese government's flagship initiative known as Simantri is being examined in this study for its sustainability. It is inextricably linked to the agriculture industry, which is relevant to the sustainability of the Simantri program in this study.

Referring to the description above, this Simantri sustainability research needs to be carried out to determine probability and sensitivity scenarios driving the sustainability of the Simantri program. The Simantri program's viability will depend on farmers' potential choices on its implementation. As a result, the findings of this study offer potential recommendations to stakeholders for the sustainability of Simantri program. Additionally, the sensitivity of each scenario can be considered about the accuracy of the scenarios that will be implemented.

LITERATURE REVIEW

Simantri Program

Crop-livestock integration activities have helped enhance agricultural development and spread throughout Indonesia's varied areas and agro-ecosystems as a farming practice. This pattern is considered to have diverse effects on the integration process with other larger corporate development programs and serve as a source of family income. In addition to being one of the potentials for achieving the National Beef Self-sufficiency Program (PSDS) in 2014, which has been planned in five main activities and 13 operational activities by the Director General of Animal Husbandry (Ashari *et al*., 2016; Kariyasa, 2005), various patterns of crop-livestock integration, both commodity-based and agroecosystem-based, have become part of efforts to support domestic beef cattle breeding businesses (Santoso, 2016; Winarso & Basuno, 2013).

A crop-livestock integration system is one farming system that can help agricultural development in rural regions (Anugrah *et al*., 2014). The key characteristic of crop and livestock integration is the mutually beneficial link. This connection may be seen in using trash from each component and the division of land, which is mutually integrated. The various integration system components interplay catalyzes the increase in agricultural communities' incomes and long-term regional economic growth (Rusastra, 2016; Septiadi *et al*., 2021; Sujana *et al*., 2016). In other words, the system for integrating crops and livestock has three key goals: enhancing economic growth and welfare, enhancing food security, and preserving environmental sustainability (Anugrah *et al*., 2014).

The Prima Tani development model, which was developed by the Bali Province Agricultural Technology Assessment Center (BPTP) in one of the places he visited, served as the basis for the Simantri concept that the Governor of Bali first proposed (Anugrah *et al*., 2014; Mudiarta, 2012). The governor and other public officials were shown a description of integrated agricultural activities when the Prima Tani model was introduced. This description provided the initial impetus for incorporating the Prima Tani model into Bali Province's Simantri program to support regional strategic programs. This concept was later developed into the Simantri program. One of the key initiatives advancing Bali Province's strategic program policy for Bali Mandara (Bali Forward, Safe, Peaceful, and Prosperous) is the Simantri program (Anugrah *et al*., 2014).

The Association of Farmers Groups (*Gapoktan*) in a particular village area is the goal of Simantri's efforts (Dananjaya *et al*., 2014; Karnawan *et al*., 2017). Villages with agricultural potential and superior commodities to serve as leverage, *Gapoktan* who are willing and able to carry out integrated operations, and priority for villages with poor households (RTM) of more than 35% are the criteria for *Gapoktan* in question. The Simantri initiative is hoped to succeed within a short period (3–4 years).

The development of institutions and human resources for agricultural officers and farmers, the creation of jobs through the diversification of agricultural businesses and domestic industries, the development of farming intensification and extensification, and increased incentives for farming through increased production and farming efficiency (fertilizer, feed, biogas, biourine, and self-produced biopesticides) are all examples of indicators of level of achievement (Anugrah *et al*., 2014). Technically speaking, the Simantri program's objectives include: expanding the planting area, livestock population, fisheries, and product quality; ensuring year-round access to high-quality fodder; ensuring the availability of fertilizers, organic pesticides, and biogas; and fostering the diversification of rural businesses, establishment of economic business institutions, and development of infrastructure (Anugrah *et al*., 2014; Darmawan & Triyowati, 2016). Agriculture is anticipated to be managed in an integrated fashion through implementing the Simantri program, which provides farmers with multiple benefits and reduces the time required to receive benefits (Anugrah *et al*., 2014; Karnawan *et al*., 2017). The Simantri development scenario is critical to Simantri's continued existence and utility. The objective of the Simantri program is to facilitate the integration of agriculture by providing numerous advantages to producers and reducing benefit waiting periods. The Simantri development scenario is critical to Simantri's continued existence and utility.

Sustainability of Simantri Program

The Association of Farmers Groups (*Gapoktan*) in a particular village area is the goal of Simantri's efforts. Villages that have agricultural potential and superior commodities to serve as leverage, *Gapoktan* who are willing and able to carry out integrated operations, and priority for villages with poor households (RTM) of more than 35% are the criteria for *Gapoktan* in question (Anugrah *et al*., 2014; Karnawan *et al*., 2017; Rhismawati, 2023). The Simantri initiative is hoped to succeed within a short period (3–4 years). The development of institutions and human resources for agricultural officers and farmers, the creation of jobs through the diversification of agricultural businesses and domestic industries, the development of farming intensification and extensification, and increased incentives for farming through increased production and farming efficiency (fertilizer, feed, biogas, biourine, and self-produced biopesticides) are all examples of indicators of level of achievement. Technically speaking, the Simantri program's objectives include expanding the planting area, livestock population, fisheries, and product quality; ensuring year-round access to high-quality fodder; ensuring the availability of fertilizers, organic pesticides, and biogas, fostering the diversification of rural businesses, establishment of economic business institutions, and development of infrastructure.

Assuming 20,000 cows, Simantri products have the greatest ability to satisfy Bali Province's demand for organic fertilizer and biourine. The number of cows kept on a large scale can also produce biogas, which can be used as a potential energy source to satisfy the energy requirements of farming households or the regional energy

demands in general. The number of products produced is anticipated to rise. At the same time, farming costs decline due to the potential for increased crop productivity from the crop-livestock integration pattern, presuming that organic fertilizers are applied according to regulations and the fertilizer needs are satisfied through Simantri activities. Simantri's ultimate objective of doubling farmers' income within 3–4 years can be accomplished immediately, provided that integrated farming is implemented in a good system and all its sub-systems function synergistically and sustainably.

Based on the potential and acceleration of Simantri activities as well as the policy support from the Provincial Government of Bali and 9 regencies and cities, there is a great hope that the Simantri concept will one day have been implemented in 400 of the 1,000 target locations in the process of achieving agricultural and rural development goals through the Simantri program (Anugrah *et al*., 2014; Santikasari *et al*., 2016). One may get to *Gapoktan*. Simantri, whose construction is scheduled to begin in 2018, has the potential to be one of the "embryos" of independent farming and to strengthen rural communities by providing food (vegetable and animal), organic fertilizer (solid and liquid), and bioenergy for domestic use. This activity also catalyzes the growth of other associated organizations and nodes of economic activity that will eventually lead to an integrated agriculture-energy system that will increase farmer welfare and food self-sufficiency.

It is necessary to thoroughly analyze the Simantri program's sustainability in light of the sustainability principles regarding economic, social, and environmental factors. This program will become more focused, able to take advantage of possibilities, and less likely to have negative effects as it develops if the sustainability component is considered. This is consistent with the advantages of using a crop-livestock integration system pattern, according to Elly *et al*. (2008). The intended advantages include: (1) diversifying the use of production resources; (2) lowering business risks; (3) maximizing labor efficiency; maximizing input efficiency; reducing reliance on chemical and biological energy and input sources; (6) improving the ecological system's sustainability and environmental friendliness; (7) increasing output; and (8) being able to create sustainable farm practices. A sustainability analysis is required to provide empirical support for the theoretical certainty of the benefits the Simanttri program will deliver. The alignment of program benefits with economic, social, and environmental factors constitutes sustainability analysis (Anugrah *et al*., 2014; Fauzi, 2019).

Hyphotesis/scenario of sustainability Simantri Program

The basic idea of integrated crop and livestock agriculture suggests that efforts to accomplish Simantri's objectives involve managing the results of both processing and business activities for crop production and livestock business and a process of institutional strengthening. Simantri's regional agricultural development program policies are anticipated to become one of the models for regional agricultural

development toward an integrated energy-agriculture system for food self-sufficiency and farmer welfare with the help of the fundamental concepts, potential, opportunities, and regional policy support if all processes and stages of the organization's activities are carried out methodically. Assuming that the process of changing regional leadership and the adjustments in development policy interests accompanying it do not distort the process for accomplishing goals in that direction.

To increase the sources of revenue for farmers and groups, Simantri initiatives already have the potential to generate business diversification at the farmer and community level (Pratiwi *et al*., 2021). The Provincial Government of Bali and the Regency/City have also started creating opportunities for business development, farmer capacity building, and product marketing through various progressive steps and supporting policies to open the door for successful business development, which *Gapoktan* Simantri is carrying. Given that all stakeholders and policymakers involved in the Simantri program can carry out their respective roles based on the conception that has become a guide or reference for all related elements, the linkages of all nodes have demonstrated strong synergy, allowing the process of accomplishing the Simantri program objectives to be carried out in stages (Anugrah *et al*., 2014; Karnawan *et al*., 2017; Lestari *et al*., 2023).

The sustainability analysis research hypothesis is a scenario based on sustainability considerations (Fauzi, 2019). Several study findings and prospective disturbances are the foundation for the proposed research hypothesis or scenario to continue the Simantri program. The Simantri program has three formulations or scenarios:

H1: Farmers solely produce livestock (cows).

H2: Farmers raise livestock and also use livestock dung as fertilizer (economic side).

H3: Farmers raise livestock and also engage in commercial activities.

RESEARCH METHODS

This study was carried out in Tabanan Regency with consideration for Jatiluwih Village, a village with its Subaks being a world cultural heritage, and Tabanan, where they can support each other in sustainable agricultural development. Tabanan has the second-highest concentration of *Gapoktans* in Bali Province, or 115 *Gapoktans*, and has the highest potential for agricultural area in Bali. To obtain comprehensive information about the hypothesized probability scenario for the Simantri program's sustainability, the survey research method was used, with data

from a saturated sample of 115 *Gapoktans* used as material for consideration and comparison of the results of Focus Group Discussions (FGD) with relevant experts and stakeholders, with as many as 19 respondents.

The Smic-Prob Method, or more specifically, the Smic-Prob Expert, precisely scenario analysis, is one approach that can be utilized for sustainability. Scenario analysis is used to evaluate the likelihood that an action (event), in this research the Simantri program, will occur or not based on opportunity theory (Godet *et al*., 2004). SMIC-Prob determines whether or not a scenario combination should be adopted based on the outcomes of these opportunities. analysis by including components of uncertainty (Fauzi, 2019). The number of observed scenarios follows the formula r = 2^n, where r is the number of scenario combinations and n is the total of observed situations, so that this analysis includes as many scenarios as there are four observed scenarios.

The selection of different event scenarios is based on the expert opinions from the Simantri program, which were obtained through FGDs or by answering surveys, which may be written as H= (e_1, e_2,… e_n), where e_1 - e_n signify events or activities. The FGD additionally establishes the conditional probability and the simple probability P(i), of each scenario as follows:

$P = \left(i/j\right)$ is Probability of scenario i if scenario j occurs 1

$P = \left(i/\bar{j}\right)$ is probability of scenario i if scenario does not occur..... 2

SMIC-prob additionally needs the prerequisites for each opportunity to function, namely:

$0 \leq P(i) \leq 1$..... 3

$P(i/j)P(j) = P(j/i)P(i) = P(ij)$ 4

$P(i/\bar{j})P(j) + P(i/\bar{j})\,P(\bar{j}) = P(i)$ 5

By determining the probability combination score using the objective function utilizing the quadratic programming approach:

$min \sum_{ij}^{n} \left[P(\frac{i}{j})P(i) - \sum_{k=1}^{r} P(ijk)\pi_k\right]^2 + \sum_{ij}^{n} \left[p\left(\frac{i}{\bar{j}}\right)p(\bar{j}) - \sum_{k=1}^{r} s(ijk)\pi_k\right]^2$ 6

With constraints:

$\sum_{k=1}^{r} \pi_k = 1$ dan $\pi_k =\geq 0$ 7

The symbol π_k describes the opportunity scenario k whose value is sought from the minimization solution above. The value of t(*ijk*) will equal 1 when the *i* and *j* events occur in scenario *k*, and zero when the *i* and *j* events do not occur in scenario *k*. The value of s(*ijk*) will be equal to 1 if the value of event *i* occurs in scenario *k* but event does not occur. Conversely, s(*ijk*) will be zero if event *i* does not occur, but event *j* occurs in scenario *k*.

The quadratic programming problem results in a table that lists the opportunities in order of highest to lowest score and the elasticity value of the probability for each occurrence.

$e_{ij} = \frac{P(i)\Delta P(j)}{P(j)\Delta P(i)}$ 8

This stage generally involves obtaining data about the Simantri Program that has been observed with the stages shown in Figure 1.

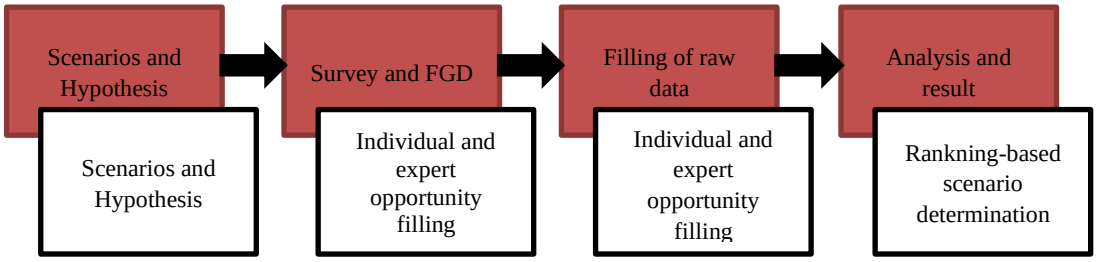


Figure 1
SMIC-Prob Analysis Stages
Source: Fauzi (2019)

The FGD experts calculate the postulated likelihood based on their comments' adequacy. SMIC-Prob uncertainty analysis involves multiple steps that result in a variety of scenarios.

RESULTS AND DISCUSSION

Simantri Program Sustainability Probability Scenarios Combined

The first step in the SMIC-Prob analysis stage is determining which probability scenarios will be examined. In this study, the scenario is the possible things farmers in *Gapoktan* could do to make the Simantri Program work. Based on the questionnaire results adjusted to the FGD results, four (4) scenarios for the sustainability of the Simantri Program have been identified, such as (1) farmers only raise livestock (cattle); (2) besides raising livestock, also utilize livestock manure for fertilizer (economic side); (3) raise livestock and also do commercial side (commercial); and

(4) does not optimize assistance (not optimal).

SMIC-Prob analysis results

Determination of the Simantri Program Sustainability Probability Scenario

The initial stage in Smic-Prob analysis is calibration from raw data to net data, which recalculates basic and conditional probability values from raw data to become net data. The calibration outcomes for *Gapoktan* action scenarios from raw data to straightforward opportunity net data are shown in Figure 2. Choosing which probability scenarios to examine is the first step in the SMIC-Prob analysis stage. The scenario used in this study is the potential actions that farmers in *Gapoktan* could take to make the Simantri program successful. Four (4) scenarios for the sustainability of the Simantri Program have been identified based on the questionnaire results adjusted to the FGD results, namely: (1) farmers only raise livestock (cattle); (2) in addition to raising livestock, they also use livestock manure for fertilizer (economic side); (3) they raise livestock and also do commercial side (commercial); and (4) they do not optimize assistance (not optimal).

	Probabilities
1 : Cattle	0,5
2 : sideeconom	0,65
3 : Notoptimal	0,35
4 : Commercial	0,6

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(a)

	Probabilities
1 : Cattle	0,585
2 : sideeconom	0,529
3 : Notoptimal	0,449
4 : Commercial	0,6

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(b)

Figure 2
Raw data (a) and net data (b) simple probabilities (Pi)

	Cattle	sideeconom	Notoptimal	Commercial
1 : Cattle	0,585	0,619	0,413	0,515
2 : sideeconom	0,559	0,529	0,495	0,597
3 : Notoptimal	0,317	0,421	0,449	0,4
4 : Commercial	0,528	0,678	0,534	0,6

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$(P_{i/j})$

	Cattle	sideeconom	Notoptimal	Commercial
1 : Cattle	0	0,548	0,726	0,691
2 : sideeconom	0,486	0	0,556	0,426
3 : Notoptimal	0,636	0,481	0	0,523
4 : Commercial	0,701	0,512	0,653	0

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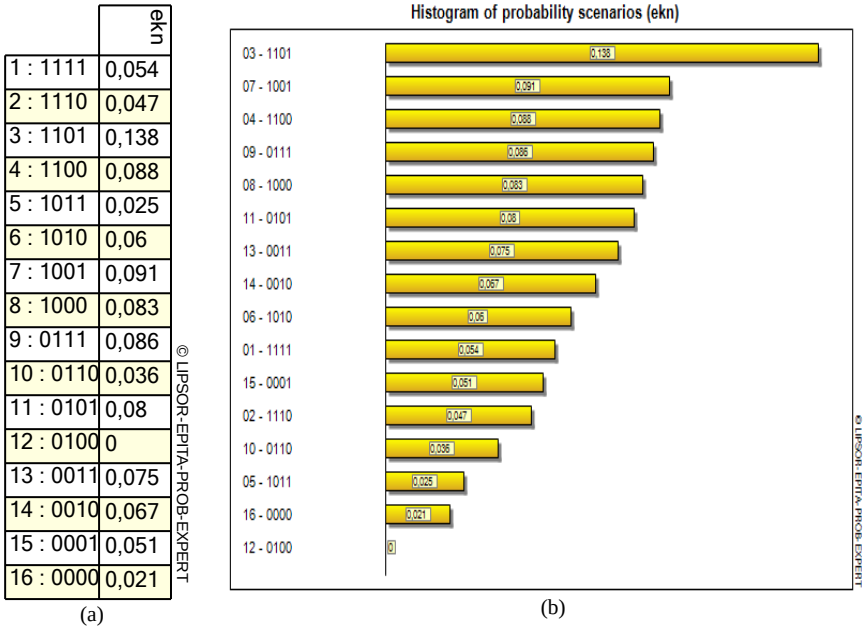
$(p_{i/\bar{j}})$

Figure 3
Net data for conditional opportunities: Realized (a) and not realized (b)

Changes between raw data and net data on straightforward opportunities Figure 2 shows a transition, with farmers who only raise cattle, for example, going from being

in Figure 2(a) to 58.50% in Figure 2(b), following calibration. And there is another scenario that indicates a reduction in opportunities, namely for farmers who, in addition to producing animals, also use livestock waste to create organic fertilizer and use it in agriculture, such as growing chilies and other crops (side economist). Figure 2(a) shows the initial probability as 0.65 (65%), while Figure 2(b) shows it as 0.529 (52.9%). (b). The following discussion uses the findings of an analysis using net data. Figure 3 illustrates this further by showing the net conditional opportunity data that may or may not be achieved.

Figure 4 illustrates the 16 scenario combinations that can be used to rank the 2n potential scenario combinations, where n in this study corresponds to the 4 possible scenarios. The numbers "1" and "0" indicate whether a scenario comes to pass in each combination. Figure 4(a)s demonstrate that the initial combination, 1111, has a chance of 0.054 (5.4%) and that the four scenarios for *Gapoktan* activities have a very low probability of being carried out.



	ekn
1 : 1111	0,054
2 : 1110	0,047
3 : 1101	0,138
4 : 1100	0,088
5 : 1011	0,025
6 : 1010	0,06
7 : 1001	0,091
8 : 1000	0,083
9 : 0111	0,086
10 : 0110	0,036
11 : 0101	0,08
12 : 0100	0
13 : 0011	0,075
14 : 0010	0,067
15 : 0001	0,051
16 : 0000	0,021

(a) (b)

Figure 4
Probability of Various Scenarios (a) and Order of Scenario Combinations Based on the Number of Chances (b)

While combination 03, which has a probability of 1101 of 0.138 (13.8%), is the alternate combination with the highest likelihood, Figure 4(a) shows that in the combination of scenarios, farmers who only raise livestock (cattle) also use livestock manure as organic fertilizer used in agriculture, as well as farmers who also sell fertilizer made from livestock manure, process their agricultural products, like chilies, into chili powder, dried chilies, and integrated farming (commercial). This can be explained by the questionnaire results and the findings of the focus group discussions (FGDs) with experts; in fact, the majority of farmers fall under scenario (2), i.e., those who, in addition to raising livestock, also use livestock manure to create organic

fertilizer, which is then applied to crops like chili plants, etc. Following a sensitivity study, it will be determined which of these combinations is most sensitive to promoting the sustainability of the Simantri Program. Combination 03 appears to have the highest chance based on the sequence of opportunity combinations. For instance, Simantri in Gianyar Regency, which is in combination 03, namely commercial, using Japanese technology, is able to convert animal manure into organic fertilizer at the Tumang Sejahtera Simantri 096 *Gapoktan*. This is made possible by a partnership with the Osaki City Government and the support of the Provincial Government of Bali and the "Japan International Corporation Agency" (JICA) (Wiguna, 2017). The histogram for sorted scenario combinations is shown in Figure 4(b). The combination of scenarios with the highest likelihood is one in which farmers use an integrated (commercial) system to enhance their welfare.

Impact Between Scenarios

The hypotheses or scenarios for the conduct of the *Gapoktan* farmers will affect other hypotheses or scenarios, whether they come true or not. shown in Figure 5. Figure 5(a) demonstrates that if the farmer's action scenario of only raising livestock (cattle) is realized, then the likelihood that farmers will not optimize assistance will decrease by 0.172 (17.2%). It also demonstrates that the opportunity for farmers to do side businesses, such as selling organic fertilizer made from processed manure and being used alone and farming chilies and other crops (commercially), will also decrease by 0.07 (7%). Yet, the odds in terms of the economy went up by 0.034 (3.4%).

	Cattle	sideeconom	Notoptimal	Commercial
1 : Cattle	0	0,034	-0,172	-0,07
2 : sideeconom	0,03	0	-0,033	0,069
3 : Notoptimal	-0,132	-0,028	0	-0,049
4 : Commercial	-0,072	0,078	-0,066	0

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(a). P(i/j)- P(i)

	Cattle	sideeconom	Notoptimal	Commercial
1 : Cattle	-0,585	-0,038	0,14	0,105
2 : sideeconom	-0,043	-0,529	0,027	-0,103
3 : Notoptimal	0,186	0,032	-0,449	0,074
4 : Commercial	0,102	-0,087	0,054	-0,6

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(b). ($p_{i/\bar{j}}$)- P(i)

Figure 5
Impact of the realized scenario (a) and impact of the unrealized scenario (b) on other scenario opportunities

The calculation of the difference between conditional opportunities and simple opportunities from net data yields the result of -0.172, which is equal to the difference between $\left(p_{i/\bar{j}}\right)$ farmers raising livestock only (cattle) to farmers who do not optimize assistance (not optimal) of 0.413 (Figure 3a) minus P(i) cattle (raising livestock only) of 0.585 (Figure 2b). Figure 5(b) describes the consequences and influence on scenario j if scenario I is not achieved. If the opportunities for *Gapoktan* farmers who do not optimize assistance are not realized, for instance, the opportunities for farmers who only raise livestock (cattle) will increase by 0.186 (18.6%), as calculated by the difference in numbers $\left(p_{i/\bar{j}}\right)$ and the opportunity for farmers not to optimize assistance

(not optimal) to livestock raising farmers only (cattle) of 0.636 (63.6%), Figure 3(b), minus p(i) from not optimal, namely 0.449 (44.9%). The rounded value for Figure 2(b) is 0.187 (18.7%). However, the chance for an integrated (commercial) system will rise by 10.5% if farmers who just rear livestock (cattle) are not realized. P(i) from cattle at 0.585 (58.5%) in Figure 2(b)) is equal to 10.5% of the difference in the number of opportunities for farmers who exclusively raise animals (cattle) to sell to commercial farmers (see Figure 3(b)) (rounded). The reason for this is that *Gapoktan* farmers will be able to improve agricultural productivity, quality, soil health, and socioeconomic balance if they can combine traditional knowledge with cutting-edge agricultural techniques like zero waste farming and the production of 4 F (food, feed, fertilizer, and fuel) Furthermore, rather than relying solely on government assistance, the use of technology in waste processing will add value. Farmers do not only raise livestock. The commercial scenario in this study is included in the combination of scenarios with the highest chance of being realized (De *et al*., 2019).

Scenario Sensitivity Analysis of Program Sustainability Drivers

The sensitivity analysis on the SMIC-Prob results is measured by elasticity, namely how responsive the opportunity changes from one scenario to another. The results of the elasticity analysis in this study are shown in Figure 6, where the last column is the absolute value of elasticity for each scenario (horizontal summation), which can be interpreted as the "prime mover" or the main driver of the system being analyzed. while the last line (vertical summation) can be said as a scenario or conditional action.

	Cattle	sideeconom	Notoptimal	Commercial	Absolute value
1 : Cattle	1	-0,378	-0,744	-0,555	1,677
2 : sideeconom	-0,27	1	-0,348	-0,217	0,836
3 : Notoptimal	-0,471	-0,357	1	-0,379	1,207
4 : Commercial	-0,541	-0,269	-0,534	1	1,344
5 : Absolute value	1,282	1,004	1,626	1,151	_

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Figure 6
Elasticity of Scenarios

With elasticity values of 1.677 and 1.344, respectively, the scenario of the *Gapoktan* farmer who just grows livestock (cattle) and who engages in side business is a "primary mover," meaning that these two possibilities will have a significant impact on whether the Simantri program is sustainable. The results of focus groups with experts or actors show that farmers who only raise livestock, which means they only rely on assistance and integrate the agricultural system, operate a business making organic fertilizers for sale and use in agriculture, and process their agricultural products once more, experience a variety of results. According to Anugrah et al. (2014), the likelihood of agricultural sustainability is higher with integrated farming

systems. Simantri, which is implemented by strengthening the functional relationships of each activity and using technology can promote the use of agricultural and livestock waste to become a supporting component for integration focused on zero waste farming and produce 4 F (food, feed, fertilizer, and fuel) (Borch, 2007).

The findings of this study are consistent with those of other studies that have focused on Simantri in the Province of Bali, which demonstrate that the implementation of the livestock integration model affects the development of the local economy, the creation of jobs, and the provision of food, feed, fertilizer, and organic and biogas pesticides at the group level and for commercial use with the support of local government policies. It is believed that the potential, opportunities, and policy support in executing Simantri activities will serve as a seed for expanding the regional agricultural sector development program toward an integrated energy agriculture system for food self-sufficiency and farmer welfare. Assuming the Simantri Program's sustainability is unaffected by the process of shifting regional leadership and related political interests (Anugrah *et al*., 2014; Budiasa, 2010).

The scenario of not optimizing assistance, on the other hand, is the one that is heavily influenced by an elasticity of 1.626, of which the largest contributor is from cattle, which is -0.744. In other words, if farmers who only raise livestock (cattle) increase by 1005, opportunities for farmers who do not optimize assistance will decrease by 74.4%. This means that the success of the Simantri program will depend on how well *Gapoktan* farmers take care of their cattle, exhibit entrepreneurial spirit, and use IT to promote integrated system agriculture like Simantri, which will be able to make agriculture more generally sustainable (Hrubovcak *et al*., 1999). Due to this, farmers' chances of not maximizing help may drastically decline.

Tables 1 and 2 give the findings of the sensitivity analysis concerning the most likely scenario and the size of the opportunity between being implemented and not being implemented. According to Table 1, which summarizes the results of each scenario, the farmer scenario (commercial) has the highest overall chance (0.6 or 60%). followed by 58.6% of farmers who exclusively raise animals (cattle).

Table 1
Recapitulation of Opportunities for Each Scenario

Cattle	Sideecon	Not optimal	Commercial	Opportunity
1	1	0	1	0.138
1	0	0	1	0.091
1	1	0	0	0.088
0	1	1	1	0.086
1	0	0	0	0.083
0	1	0	1	0.08
0	0	1	1	0.075
0	0	1	0	0.067
1	0	1	0	0.06
1	1	1	1	0.054
0	0	0	1	0.051
1	1	1	0	0.047
0	1	1	0	0.036

Cattle	Sideecon	Not optimal	Commercial	Opportunity
1	0	1	1	0.025
0	0	0	0	0.021
0	1	0	0	0
0.586	0.529	0.45	0.6	1.00

Table 2 contrasts commercial scenarios between those carried out with and without the code (with a "1" at the end) ("0" at the end). The potential is greater if the commercial scenario is achieved at 0.6 than if it is not, at 0.402. According to sustainability analysis in agriculture using probability scenarios, it is necessary to identify the major problems and change catalysts currently anticipated to be significant in a policy context in the medium and long term. Additionally, it is necessary to make strategic decisions to deal with the policy-making uncertainties (Fauzi, 2019).

Table 2
Commercial Realization Comparison

Scenario Combination	Commercial Opportunities=1	No.	Scenario Combination	Commercial Opportunities=1
"1101"	0.138	4	"1100"	0.088
"1001"	0.091	8	"1000"	0.083
"0111"	0.086	14	"0010"	0.067
"0101"	0.08	6	"1010"	0.06
"0011"	0.075	2	"1110"	0.047
"1111"	0.054	10	"0110"	0.036
"0001"	0.051	16	"0000"	0.021
"1011"	0.025	12	"0100"	0
Amount	**0.6**			**0.402**

The opportunity between being realized and not being realized is bigger than the commercial opportunity that is being realized, as seen in Table 2. This demonstrates how crucial it is to inspire more *Gapoktan* to pursue entrepreneurship through integrated farming to enhance their welfare.

CONCLUSIONS

The Simantri program's sustainability can be achieved through commercial, economic, and cattle-related situations. Compared to the other combinations suggested in the analysis, this combination has the highest chance (13.8%). The modest and commercial scenarios are "prime over" among those that have the potential to run in the ongoing Simantri program. The scenario with the greatest chance of being put into practice with an elasticity level of 1.344 is the commercial one. To continue the Simantri program, it is necessary to consider the economic benefit component in the form of commercial activity in this situation. This is consistent with the goals established by the government's Simantri program. By implementing the Simantri

program, farmers also have this situation in mind.

The results have implications for the focus of the development of the Simantri program which must be aligned between stakeholder expectations and the actual conditions of the field provided by the scenarios used in this study. The research findings also offer suggestions for further investigation into the cancellation of the Simantri initiative, which may involve economists and war experts to set up scenarios. Following the conditions of the region and its integration with the vision being carried out to realize growth, the scenarios that have been developed are projected to be able to provide technical and more operational answers.

The conclusions must be reviewed if they apply to other districts because the research focuses on the Tabanan Regency. This is essential due to the likelihood of variations in farmer personalities, regional customs, and socioeconomic realities. Since Simantri is a provincial government program, research on its sustainability should be conducted in a wider area. The scenarios suggested in the research also need to consider regional socio-economic and cultural factors. The findings can be used as a beginning point in sustainability research to identify programs, strategies, and policies for achieving systemic sustainability in addition to scenario analysis.

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