PROCEEDING

The 2nd ICFST

International Conference on Sustainable Cereals and Crops Production System in the Tropics

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The 2nd International Conference on Sustainable Cereals and Crops Production Systems in the Tropics (ICFST)

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PREFACE: The 2nd International Conference on Sustainable Cereals and Crops Production Systems in the Tropics (ICFST)

The 2nd International Conference on Sustainable Cereals and Crops Production Systems in the Tropics (ICFST) was held on 23-24 September 2021 in Makassar, Indonesia. The Conference was organized by Indonesian Agency for Agricultural Research and Development (IAARD)-Ministry of Agriculture of Indonesia, collaborated with International Maize and Wheat Improvement Center (CIMMYT) and Ministry of Research, Technology and Higher Education of Indonesia.

The theme of the conference is "Sustainable Agricultural Resources Management to Support Food Security and Industry 4.0" with the sub themes of Breeding and Biotechnology, Crop Production Systems, Pest and Disease Management, Post Harvest, Seed Production and Socio Economic. The conference was held virtually via zoom and arranged in plenary and parallel session in two days of scientific session. The conference facilitate the research community focusing in food crops and provide platform for scientists tomeet and interact with each other to share their knowledge and their research results along withthe obstacles and challenges they faced in their development, achievement as well as experiences through the presentation of papers and discussion. This international conference isalso an event to establish cooperation in the development of food crops research in the future as well as enhancing the knowledge of environmental protection with the current agricultural technologies.

We would like to convey our deepest gratitude to the Minister of Agriculture of Indonesia, Keynote Speakers: Dr. Kevin Pixley (Director of the Genetic Resources Program CIMMYT), Invited Speaker : Dr. Juan Landivar Bowles (Resident Director and Professor, Texas A&M AgriLife Research, USA), Dr. Keerti S. Rathore (Professor , Dept. of Soil & Crop Sciences Institite for Plant Genomics & Biotechnology, Texas A&M University, USA), Prof Bunyamin Tar'an (University of Saskatchewan Canada), Dr. Naori Miyazawa (Lecture and Researcher, Nagoya University, Japan), Dr. Yu-Shin Nai (Assistant Professor, National Chung Hsing University, Taiwan) sponsors, organizing committee and also to all participants.

We also would like to express our deepest gratitude to the Indonesian Agency for Agricultural Research and Development (IAARD) conducted such conference. We expect that these future ICFST conference will be as stimulating as this most recent one was, as indicated by the contributions presented in this proceedings volume.

Makassar, 23-24 September 2021

IAARD

Indonesia

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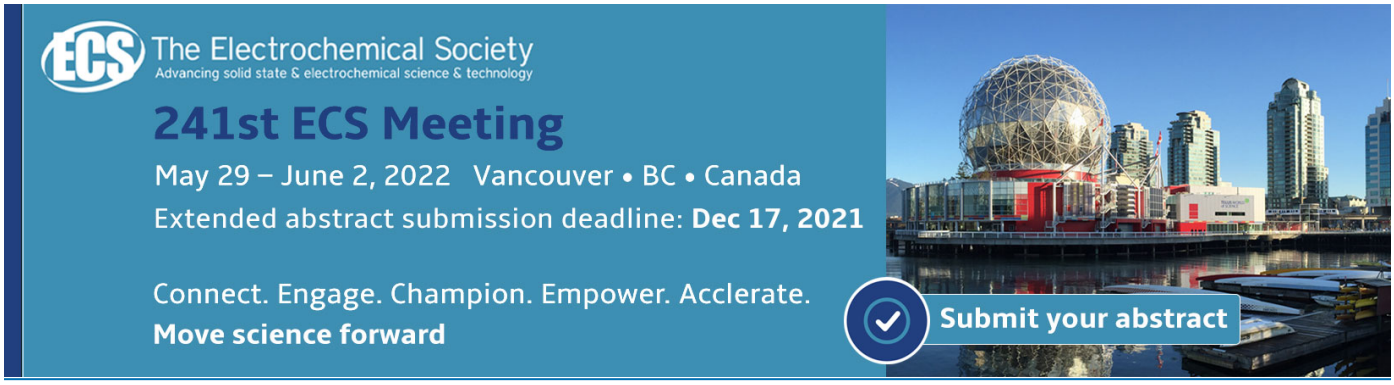

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PREFACE: The 2nd International Conference on Sustainable Cereals and Crops Production Systems in the Tropics (ICFST)

The 2nd International Conference on Sustainable Cereals and Crops Production Systems in the Tropics (ICFST) was held on 23-24 September 2021 in Harper Hotel Makassar, Indonesia. The Conference was organized by Indonesian Agency for Agricultural Research and Development (IAARD)-Ministry of Agriculture of Indonesia, collaborated with International Maize and Wheat Improvement Center (CIMMYT) and Ministry of Research, Technology and Higher Education of Indonesia.

The theme of the conference is "Strengthening Agricultural Resources Management to Support Food Security and Industry 4.0" with the sub themes of Breeding and Biotechnology, Crop Production Systems, Pest and Disease Management, Post Harvest, Socio-Economy and Community Development. The conference was conducted in two days offline/on site and virtual scientific sessions. Due to the pandemic reason, offline/on site meeting was limited to a maximum of 100 participants and the remaining 900 participants joined via virtual zoom meeting. The conference facilitate the research community focusing in food crops and provide platform for scientists to meet and interact with each other to share their knowledge and their research results along with the obstacles and challenges they faced in their development, achievement as well as experiences through the presentation of papers and discussion. This international conference is also an event to establish cooperation in the development of food crops research in the future as well as enhancing the knowledge of environmental protection with the current agricultural technologies.

We would like to convey our deepest gratitude to the Minister of Agriculture of Indonesia, Keynote Speakers: Dr Kevin Pixley (Director of Genetic Resources Program CIMMYT & the CGIAR Research Program), Prof. Keerti S. Rathore (Texas A&M University, USA), Dr. Juan Landivar Bowles (Texas Agrilive-USA), Prof Bunyamin Tar'an (University of Saskatchewan Canada), Dr. Yu Shin Nai (Chung Sing University-Taiwan), Dr. Naori Miyazawa (Nagoya University), sponsors, organizing committee and also to all participants.

We also would like to express our deepest gratitude to the Indonesian Agency for Agricultural Research and Development (IAARD) conducted such conference. We are looking forward to the 3rd ICFST that will be held on September 2023 in ***Bali Island***. We expect that these future ICFST conference will be as stimulating as this most recent one was, as indicated by the contributions presented in this proceedings volume.

Makassar, 23-24 September 2021

IAARD

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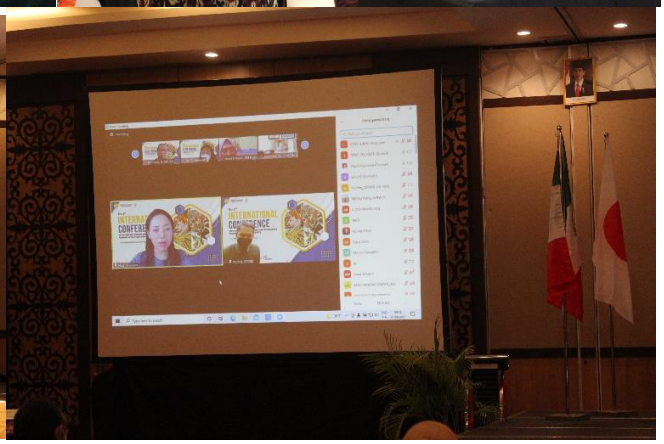

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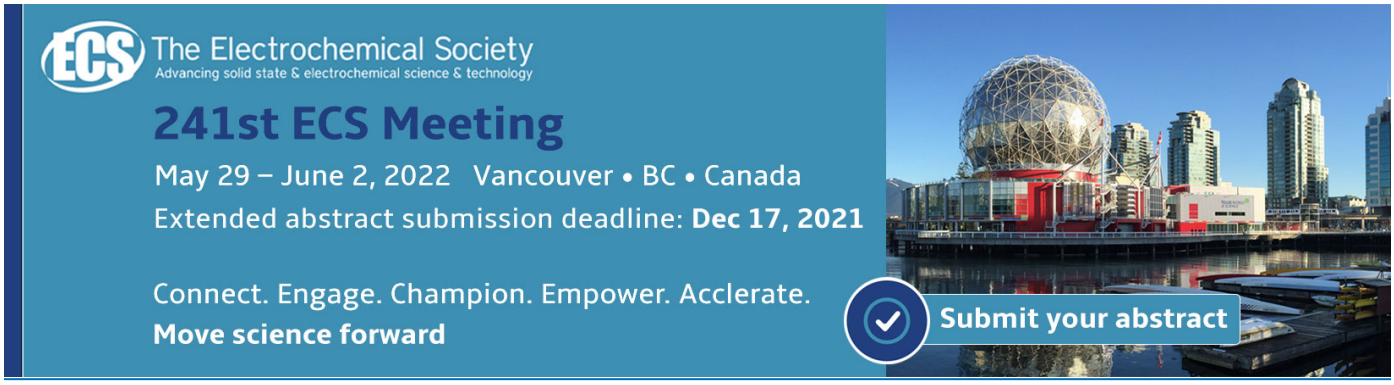

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Roles of local farmers' organization in supporting food security: case of Subak in Bali, indonesia

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Abstract. In Indonesia, agricultural development plays a significant role in economic development. The management of rice farming in Bali is closely related to the social, cultural and religious aspects of the community, especially in the management of irrigation. These traditional values with local wisdom are applied by *subak* as a farmer organization that has a role in realizing agricultural development goals, such as food security. This study aims to determine the role of *subak* in achieving and sustaining food security, particularly rice. This research was conducted in two *subak*s in Gianyar Regency, Bali. Respondents who were interviewed were all *subak* administrators (chairman, deputy chairman, secretary, treasurer, general assistant, and head of sub-*subak*, called *tempek*. A total of 40 farmers were sampled (20 farmers within each *subak*) who were selected using non-proportional random sampling technique. Data were collected using interview guidelines and questionnaires through interviews/surveys, observations and documentation. Data were fully analyzed using descriptive methods. The results showed that *subak* had several roles in increasing farmers' productivity and income. These include (i) managing the distribution and allocation of irrigation water; (ii) regulating cropping patterns and annual cropping schedules; (iii) mobilizing resources for irrigation, agriculture, social and culture, and ritual ceremony; (iv) managing subak finances/cash; (v) carrying out economic activities; and (vi) implementing government programs related to agricultural development.

1. Introduction

In developing countries including Indonesia, the existence of the agricultural sector still has a very large role in economic development. The agricultural sector in a broad sense, such as food crop agriculture, horticulture, plantation, forestry, animal husbandry, and fisheries has great potential to be further developed. In addition to the natural resources that are already available (land, water, and air), the agricultural sector also provides a productive workforce. The agricultural sector has several very important roles that require more intensive and comprehensive management. Some of the roles of the agricultural sector are: (i) providing food for the entire population; (ii) providing employment opportunities; (iii) produce raw materials that are needed by industry; (iv) consuming products produced by industry; (v) maintain the balance of nature; (vi) provide aesthetic value; and (vii) contributing to state revenues through international trade [1-4].

In essence, agricultural development carried out in Indonesia aims to improve the welfare of farmers and their families in addition to supporting the overall economic development goals at the national level. The development of rice farming as a food crop commodity has been intensively implemented by the government and farmers to meet domestic consumption for both the daily needs of the

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community and industry. Agricultural intensification in the form of special intensification, general intensification, and five farming programs as well as with sapta farming has also been carried out by the government together with farmers through farmer groups and supported by various other stakeholders. The production approach which was initially developed by the government then shifted to a commercial and agribusiness paradigm. One of the considerations is that increasing crop productivity and production, especially food, must be accompanied by various dimensions and integrated with other subsystems to increase added value and farmers' welfare.

Management of agricultural activities in paddy fields in all areas in Bali Province is based on the subak system, ranging from very small areas (about 2 ha) to hundreds of hectares. Subak is a traditional irrigation system that includes farmer organizations, irrigation and agriculture management methods, interaction patterns between farmers, ritual activities for farming in paddy fields. Based on Regional Regulation No. 9 of 2012 concerning *Subak*, it is expressly stated that the *subak* is a customary law community that is socio-agrarian and religious which historically has existed for a long time and developed as a land authority organization related to the field of irrigation water and rice regulation in a certain area. Socio-cultural values in the *subak* system are still very strong carried out by all members in the implementation of agricultural and irrigation activities. The whole series of activities in the *subak* system, both physical and non-physical, are based on its philosophy, namely *tri hita karana*, as the three causes of happiness through harmony in their interactions with God, fellow humans and the environment [5-7].The social and cultural nature inherent in the *subak* system has given confidence to the Indonesian government to propose it as a world cultural heritage. In 2012, UNESCO has recognized *subak* as one of the world's cultural heritages. This recognition as a world cultural heritage encourages the *subak* cultural system as local wisdom to be maintained and further developed by the government. and stakeholders and *subak*s. Several studies show that *subak* has multi-functional roles, in addition to producing and providing food, such as production and economic functions, environment and ecology, socio-culture, rural development, and ecotourism and agritourism [8,9].

Since the beginning of the first Five-Year Development, the government has taken advantage of the existence of *subak*, especially the Agriculture Service and the Public Works and Public Housing Service, in carrying out its programs, such as increasing agricultural productivity and product added value as well as increasing farmers' income. In addition, irrigation management to support agricultural programs, which is one of the main tasks of the Public Works and Public Housing Agency, is in dire need of a *subak* organization. Although the *subak*s are still facing various problems and challenges for the future, they remain as local agricultural institutions that have a role in irrigation management and agriculture in paddy fields. *Subak* still maintains the traditional way of carrying out farming and organizational activities. The main focus of the *subak* is the irrigation system where this organization has a unique and distinctive characteristic in the distribution of irrigation water to each member so that it is fair, effective and does not cause conflict among *subak* members.

Some of the problems and challenges faced by subaks include the availability of irrigation water at the source level, competition for water use with non-agricultural parties (PDAM, industry), pest and disease attacks, uncertainty in product prices, especially grain, increased conversion of paddy fields. who are still productive, and the reluctance of the younger generation to work in the agricultural sector [10]. Meanwhile, food security, especially rice, must be maintained and even improved. Various efforts need to be taken to overcome and anticipate the problems and challenges of subak-subak in order to encourage and strengthen subak institutions to be able to play a role in realizing food security at the provincial level. More specifically, the problem formulated is how big the role of subaks in Bali has been to support agricultural development policies and programs, such as food security. The objective of this study is to describe the roles of subak in supporting agricultural development and policies.

2. Methods

This research was conducted within two *subak*s, namely Subak Kenderan and Subak Dukuh in Kenderan Village, Tegallalang District, Gianyar Regency, Bali Province, which were selected by purposive sampling. The location of the research can be seen in Figure 1. The consideration is that these *subak*s have almost not experienced the conversion of paddy fields in the last 10 years, even though the Tegallalang District is a tourism area.

Remark:

Location of research

Figure 1. Location of research

The population in this study were all farmers and administrators of the two *subak*s. Due to limited funds, manpower and time, only key respondents, namely the *subak*s' administrators consisting of the chairman, deputy chairman, secretary, treasurer, general assistant, and head of sub-*subak*, as well as 40 *subak*s farmers were selected as (20 farmers in each *subak*) using a non-proportional random sampling technique. Data were collected using interview guidelines and questionnaires through interviews/surveys, observation and documentation. The data were fully analyzed using descriptive methods.

3. Results and Discussion

In several decades, the existence of *subak* with its superiority with its local wisdom in managing irrigation water and carried out independently for the management of farming in paddy fields, such as rice and secondary crops. The traditional system of *subak* is not solely involved in irrigation management, but is also closely related to the provision of food, land and water ecosystems, including socio-cultural values such as religious rituals related to rice farming [11]. The existence of *subak* is one part of the three main pillars of culture in Bali, while the other two pillars are traditional villages or *pakraman* villages and Hindu cultural values [12]. *Subak* has a philosophical foundation based on Hinduism, namely Tri Hita Karana which emphasizes balance and harmony, namely balance and harmony between humans and each other, with their natural environment and with God Almighty as the creator of everything that exists in this universe [5]; [13]. Indriani, revealed that the existence of *subak*s in Bali has been able to contribute to the realization of food availability through the implementation of various agricultural development programs in addition to preserving the agricultural culture and Balinese culture [14]. The results of the research on the two *subak*s through interviews and direct observations at the location, can be described several roles of *subak* in relation to the

achievement of food security, rice, such as managing the distribution and allocation of irrigation water; determining annual cropping patterns and cropping schedules; mobilizing resources for irrigation operation and maintenance, managing *subak* finance/cash, carrying out economic activities, and implementing government programs concerning the agricultural development.

3.1 Managing the distribution and allocation of irrigation water

As a traditional irrigation system, *subak* has been established by farmers since thousand years ago to manage water from the source level to rice fields through dams and irrigation canals along with other irrigation structures such as division structures, overflow structures. *Subak* is an organization of farmers who manage irrigation water in Bali which initially distributed and allocated irrigation water in paddy fields farming from the source level to the rice fields [15]. The *subak*s within research sites, irrigation water management includes the distribution and allocation of irrigation water. The management of irrigation water is closely related to the cropping pattern and the set of planting schedule.

The distribution of irrigation water in both *subak*s is based on previous experience and the agreement or consensus of all *subak*s' members. The distribution of irrigation water has the same pattern within the *subak*s, namely continuous flow and rotation. The continuous flow pattern is applied during the rainy season where water condition at the source level is sufficient for the entire existing rice field area. This means that, irrigation water on the water division structures is not closed until it goes to the rice fields of the member farmers through the water inlet. Unlike the case during the dry season, namely in the second and third planting seasons, the distribution of irrigation water is applied with a rotation pattern. The farmers had an agreement among themselves to get irrigation water through the staggering way. In this way, the irrigation water is firstly used by several farmers to cultivate their land until it is finished, then the irrigation water is given to other farmers, and so on.

Meanwhile, the allocation of irrigation water to each rice field plot is based on the traditional *subak* measurement. The unit of irrigation water allocation in the two *subak*s studied is called *tektek*. There are no technical provisions stipulated for the allocation of irrigation water. This means that if one hectare rice field gets one *tektek* water allocation, so for a two hectare rice field do not have to be given two *tektek* of water allocation. Traditionally, the determination of the amount of *tektek* is based on several things, such as the distance of rice field location from the water division structure, the nature of the rice field soil (soil porosity level), the location of the rice field (upstream or downstream), the presence or absence of runoff water from the rice fields or irrigation canals in the upstream area. These considerations have been applied since ancient times and are still in use. The results also show that the amount of *tektek* owned by each *subak*'s member has a correlation with the contribution of labor, material and cash that must be given to *subak* activities. The bigger the farmer gets the right (allocation) of irrigation water, the bigger his contribution based on the internal regulations. Subak as an organization has internal rules that are based on democratic principles and consensus among all its members [16].

Based on the results of interviews and direct observations at the research sites, information was obtained that there was a water borrowing system as a part of the irrigation water regulation that had been going on for a long time. This system is carried out on the basis of an agreement among farmers who will borrow water and farmers who will lend their water and it is submitted to the head of sub-*subak* (locally called *tempek*) or head of *subak*. Submission of water borrowers to the *subak* leadership in order to avoid allegations of water theft. In simple terms, the water borrowing in the two subaks studied was carried out in a channel building, where the inlet (water intake building) of farmers who would lend water was closed, so that water flowed to the inlet of farmers who borrowed water. The purpose of this water borrowing is to ensure the availability of irrigation water for farmers, especially during plant growth. This water borrowing usually occurs during the second and third planting seasons, so that a 300 percent planting intensity program and an increase in crop productivity can be achieved in order to achieve food and rice security. The *subak*s also had water borrowing with the other *subak*s located in the upstream and downstream areas. The management of irrigation water at the

subak and inter-*subak*s levels had shown benefits in managing rice farming, namely through water regulation both in rotation and staggering. Until now, *subak* is still able to maintain its existence, its traditional ways in carrying out agricultural, irrigation and organizational activities in order to realize justice in water distribution and realize agricultural goals [17].

3.2 Regulating cropping patterns and annual cropping schedules

One of the main functions of *subak* as an organization is to organize irrigation management in paddy fields. Irrigation management is closely related to cropping patterns and cropping schedules in one year. All of the *subak*s studied set an annual planting pattern and planting schedule which was defined in the rainy season (October). In general, the cropping patterns determined by the *subak*s are as follows:

1. Rice – rice/palawija-rice/palawija
2. Rice – rice – palawija
3. Rice – secondary crops – rice/palawija

Regulations of cropping patterns and planting schedules are largely determined by the availability of irrigation water at the source level, namely at each water intake (weir) in the river and the experience of farmers in each *subak*. Therefore, determining cropping patterns in each *subak* requires information from the government, such as the Department of Public Works and People's Housing, which had information on water availability and agricultural programs from the Department of Agriculture. The discussion on the determination of cropping patterns at the *subak* level was always attended by Field Agricultural Extension Officers and also officers from the Irrigation Sector.

In each *subak,* the cropping patterns which had already determined were implemented with the flexibility in line with the dynamics of weather changes that affect the availability of irrigation water. The flexibility imposed by the *subak*s was the change of plant species from rice to secondary crops (maize, soybeans and other crops) by some members of *subak*s because the water discharge decreases during the dry season, particularly in the third planting season. The change in planting was carried out based on deliberation at the *subak* level which was also attended by agricultural extension workers. As a consequence of this change, the *subak*s also made the decision to rotate planting in the planting season of the following year. According to the *subak*s administrators who were interviewed, if in the third planting season some subak farmer members planted palawiha, then the following year, they were given the right to plant rice, and vice versa. For *subak*s, one thing that is prioritized is an agreement to make rotation in order to fulfill and achieve the 300 percent planting intensity program, as programmed by the government through the Department of Agriculture.

The *subak*s in the research location also apply changes to the planting schedule according to the conditions of available irrigation water. The two *subak*s always set a planting schedule, especially for rice planting. As a traditional irrigation organization, the *subak*s use the Balinese Calendar to determine the auspicious days for planting rice. The calendar has included the time period or interval of time that is believed to be good for rice planting. Outside of this time period, it is believed that it will cause poor growth of plant and even failure. In addition, other auspicious days are set for tillage, seeding, planting and other activities. Therefore, determining the planting schedule for *subak*s is part of their ancestral knowledge, which is known as local wisdom.

As is the case with cropping patterns, the arrangement of the planting schedule in the dry season (second and third planting season) in the two *subak*s can be divided into two, namely staggering or sequentially and rotation. Staggering arrangements for the two *subak*s are carried out by providing farmers with an earlier opportunity to use irrigation water earlier than other farmers to cultivate their paddy fields. In accordance with the auspicious day, farmers who use the water early will soon complete their land cultivation according to schedule. Furthermore, irrigation water was given to other farmers who are ready to cultivate their land, and so on. Under these conditions, the planting schedule shifted a few days from the one previously set in order to have good cropping intensity.

Meanwhile, the rotation of water is carried out like the application of a cropping pattern. Utilization of water is carried out by giving water rights to some members of *subak* to plant rice, while other

farmers only plant secondary crops which require less water. However, in the following year these farmers who are given the right to water is obliged to give their water at a certain period to the other farmers who plant secondary crops at certain times. This means that there are two groups of farmers in one *subak*, namely a group of farmers who grow rice and a group of farmers who grow secondary crops.

Determination of cropping patterns and planting schedules as well as their flexibility guarantees the fulfillment of the planting intensity of 300 percent, in accordance with the established cropping pattern. Observations also indicate that the subak system has contributed to the achievement of agricultural programs, particularly food security. *Tri hita karana* as a philosophical foundation provides guidelines for *subak* to have a role in managing natural resources to support sustainable agricultural development programs [18-19].

3.3 Mobilizing resources for irrigation operation and maintenance

Resource mobilization in *subak* activities is related to agriculture, irrigation, organization, socio-cultural and religious rituals. In the two *subak*s, the forms of resource mobilization were in the forms of labor, materials and cash. In the form of labor, several mobilizations were carried out for mutual cooperation in repairing irrigation networks (buildings and irrigation canals), clearing canals, water division structure, tertiary boxes, rehabilitating and cleaning sacred buildings or *subak* temples, and *subak* meeting hall buildings. Under certain conditions of labor mobilization in the various types of activities mentioned above, the farmers also contributed materials, such as bamboo, stones, sand, ritual equipment and so on. In addition, these activities were also accompanied by cash contributions. Mobilization in the form of cash is needed if the cash condition of the *subak* was not sufficient for certain activities, such as repairing damaged irrigation networks and organizing ritual activities that require relatively large costs.

In the two *subak*s of research locations, the determination of the size of the contribution of either labor, material or cash is strongly influenced by the size of the allocation of irrigation water received. If a farmer gets 2 *tektek* (traditional water allocation measurement), then his contribution is counted twice when compared to the one who gets 1 *tektek*. The overall mobilization of resources begins with holding *subak* meetings to discuss and determine the type of activity, the plan for the duration of the activity, the source of financing, the implementation (whether it is mutual cooperation or hiring workers such as carpenters), and so on.

The mobilization of resources in the *subak* system makes a positive contribution to the smooth implementation of farming activities in paddy fields so that the planning of cropping patterns, planting schedules and achieving the goals of *subak* member farmers, such as increasing production of rice and secondary crops, is getting better in an effort to support food security programs from government.

One thing found in the mobilization of resources in the *subak* system is the strong mutual cooperation of member farmers in various activities. This condition indicates that *subak* is a social capital that has a function to strengthen its organization in carrying out various activities including achieving agricultural development goals.

3.4 Managing subak's finances/cash

Some of the activities that have been carried out by *subak*s in the study locations and have the potential for the development of larger economic activities are: (i) provision of agricultural inputs, such as seeds, fertilizers and pesticides; (ii) savings and loan activities among *subak* members; (iii) financial management of external assistance; (iv) financial management of duck grazing; (v) management of inactive *subak* members' contributions; (v) management of income from infringement fines; (vi) incidental contribution management (rehabilitation of irrigation facilities and ritual activities); and (vii) profit management of savings and loan units.

The provision of agricultural inputs within *subaks* were managed by the chairman, treasurer together with the secretary of the *subak*. They had responsibilities to make a written report that should be reported every month (35 days), during routine *subak* meetings. The role of agricultural extension

workers was also strongly felt by the *subak*s, especially in the preparation of seeds, fertilizers and pesticides. In the case of two *subak*s, the distribution was carried out through the *subak* and the payment was made using the *Yarnen* system (payment after harvest) to the Village Unit Cooperative. The *subak*s have their own books of account for financial management relating to transfers and payments as well as other transactions related to village unit cooperatives.

Savings and loan activities in *subak* were carried out using a simple and manual administrative system. Every month, *subak* members who borrowed cash should repay the loan in installments, the amount of which depends on the size of the loan. In both *subak*s, the loan interest rate was 1 percent per month. One thing that is interesting in this study is that there are no borrowing farmers who are in arrears in their payments. The results of interviews with *subak*s administrators, there was information that the existence of internal rules providing social sanctions for violators made them to return their debt.

In other financial administration activities, the two *subak*s manage all finances from several sources of income or income in an orderly manner. In addition, all expenditures for various activities related to agriculture, irrigation and rituals as well as several other activities are also recorded in a simple manner as well. Accountability for all finances is carried out every year, namely at a special meeting before the first planting season, namely planting rice at the beginning of the rainy season. In carrying out activities related to agriculture and irrigation, subak uses sources of financing from internal subak and external subak, such as grants [20]. Financial management in farmer organizations including the development of business activities can provide economic benefits for member farmers and at the same time provide incentives for farmers to more intensively manage their farms [21-22].

3.5 Carrying out economic activities

Economic activities in the sampled *subak*s have been running for a long time, starting from the simplest activities to more complex ones, such as the establishment of a savings and loan business unit. Economic activities at the *subak* level become a source of income for *subak* cash which will be used for agricultural, irrigation and ritual activities as well as other relevant activities. A simple activity that has been carried out since the beginning was the collection of rice production per harvest season in kind which is used as savings or *subak* cash. The amount of the contribution from the harvest was adjusted to the allocation of irrigation water received by each farmer. In the present development, the contribution of rice was calculated with cash value. *Subak* cash that had been collected was used to finance the maintenance and repair of irrigation facilities and ritual activities.

Aside from the collecting money from harvests, *subak* income is also obtained from leasing rice fields for rearing ducks. Duck grazing is carried out after harvesting because it is very certain that in the rice fields there are still grains of rice that fall down during harvest and threshing of rice. Rearing these ducks usually takes 3-5 days. The sources of *subak* financial revenue can be seen in Table 1.

Table 1. Sources of income

No	Kind of income	Frekuensi (subak)	Persentase (%)
1	Rice harvest contribution	2	100,00
2	Duck rearing	1	50,00
3	Cash contribution from passive members	2	100,00
4	Fines/sanction	2	100,00
5	Incidental contribution (rehabilitation and ritual activities)	2	100,00
	Profit of money lending		
6	Grant	2	100,00
7	a. Customary grant (every year)	2	100,00
	b. Aids from agricultural programs	2	100,00

Source: Primary data, 2021

The data presented in Table 1 shows that all of the sampled subaks have sources of income from harvests, contributions from inactive members, violation fines, incidental contributions, savings and loan unit profits, and other assistance.

3.6 Implementing government programs related to agricultural development

Since the beginning of the first Five-Year Development (PELITA), a government program that had been very intensively introduced is the implementation of the green revolution program, namely the intensification of farming of food crops (rice and secondary crops) in paddy fields. Based on the results of interviews with *subak* administrators and sample farmers, information was obtained that the government through agricultural extension workers was very intensive in providing extension and guidance about the green revolution program. This program was developed to encourage increased productivity of land and crops in order to achieve self-sufficiency in rice. Agricultural extension workers took advantage of the existence of *subak* as a forum or media to convey and disseminate agricultural innovations to farmers. The participatory approach applied by agricultural extension workers is to invite *subak* administrators to discuss and explain some of the new technologies that will be applied in paddy fields or in *subak* areas. Some of the technologies that are still remembered and well understood by *subak* member are five farming activities which include the use of new/superior seeds, tillage, fertilization technology, land and crop irrigation, pest and disease control to reach bigger target of farmers in the adoption of new technology on increasing rice productivity.

The use of *subak* in agricultural programs, especially food security and self-sufficiency in food (rice) has been well recognized by *subak* administrators and agricultural extension workers at the research sites. Some of the main reasons for using *subak*s to support and implement government programs, including:

1. *Subak* is a strong social capital in the implementation of development programs, especially agriculture;
2. *Subak* is a traditional organization that has the ability to manage irrigation both internally and externally (in collaboration with other *subak*s), especially with regard to cropping patterns, planting schedules and borrowing irrigation water from internal and external *subak*s;
3. *Subak* has rules that bind all its members because it contains social sanctions for violators; and
4. *Subak* has an organization that has a philosophy that is still being implemented, and is closely tied to beliefs that are based on religion, tradition and values. This condition is reflected in the many series of ritual activities in one rice planting season. The main pupose of which is for the growth of the rice plant to have high production and not experience crop failure.

4. Conclusion

The agricultural sector has a very important role in national economic development. The management of agricultural activities in paddy fields in all areas in Bali Province is based on the *subak* system as a traditional irrigation system. Several problems are increasingly being faced by *subak*s, meanwhile food security, especially rice, must be maintained and even improved. The results showed that several roles of subak related to food security were as follows: (i) managing the distribution and allocation of irrigation water; (ii) determining and regulating cropping patterns and annual cropping schedules; (iii) organizing resource mobilization for irrigation, agriculture, socio-cultural activities and ritual activities; (iv) administering *subak* financial/cash management; (v) carrying out economic activities; and (vi) supporting the implementation of government programs related to agricultural development.

Taking into account this conclusion, *subak* as an agricultural institution needs to be further strengthened not only for social, cultural, religious activities related to agriculture and irrigation, but also on economic aspects. The development of economic aspects in *subak* can provide economic incentives for farmers to be more intensive in managing their farming, so that food security can be realized and maintained.

References

[1] Acharya. S.S. 2006. Sustainable Agriculture and Rural Livelihoods. *Agricultural Economics Research Review.* **19** (7): 205-217

[2] Anríquez, G. and Kostas, S. 2017. Rural development and poverty reduction: is agriculture still the key?. *Journal of Agricultural and Development Economics.* **4** (1): 2007: 5-46

[3] Holcer, C.; D.A. Nadolnyak,; M. Saravia. 2013. Socioeconomic and Environmental Impact of Development Interventions: Rice Production at the Gallito Ciego Reservoir in Peru. *International Food and Agribusiness Management Review* **16**(1): 1-16.

[4] Sedana, G. 2018. Challenges of Rural Credit Institution to Accelerate Rural Economy: Case of Traditional Villages in Bali Province, Indonesia. *International Journal of Advanced Engineering and Management Research* **3**(4): 38-49.

[5] Sedana, G., I Ambarawati, W Windia. 2014. Strengthening social capital for agricultural development: Lessons from Guama, Bali, Indonesia. *Asian Journal of Agriculture and Development* **11:** 39-49

[6] Roth, D., and G Sedana. 2015. Reframing *Tri Hita Karana*: From 'Balinese Culture' to Politics.*The Asia Pacific Journal of Anthropology* **16** (2), 157-175

[7] Budhiarti, K.A.R., W. Windia, N. W. S. Astiti. 2016. Strategi Pengembangan Subak Menjadi Lembaga Berorientasi Agribisnis di Kabupaten Badung (Kasus Subak Sengempel, Desa Bongkasa, Kecamatan Abiansemal). *Jurnal Agribisnis dan Agrowisata,* **5**(4): 700-709.

[8] Sedana, G., and A. Ali. 2019. Sustaining Traditional Irrigation System through Ecotourism Development: Case of Subak of Sembung, Denpasar, Bali, Indonesia. *Proceedings of the International Conference on Industrial Engineering and Operations Management Toronto, Canada, October 23-25, 2019*:1623-1629.

[9] Sedana, G. 2020. Benefits of farmers' cooperative to rice farming activity: case of Subak's cooperative in Guama, Tabanan District, Bali province. *IOP Conference Series: Earth and Environmental Science* **484** (1): 012134.

[10] Sujana, M., M. Tamba, dan M. Sukerta. 2019. Profil Subak di Daerah Perkotaan (Studi Kasus Subak Buaji Kelurahan Kesiman Kecamatan Denpasar Timur). *Agrimeta.* **9** (17): 47-52.

[11] Aryawan, I P.S., W. Windia dan P.U. Wijayanti. 2013. Peranan Subak dalam Aktivitas Pertanian Padi Sawah (Kasus di Subak Dalem, Kecamatan Kerambitan, Kabupaten Tabanan). *Jurnal Agribisnis dan Agrowisata* **2**(1): 1-11.

[12] Budiasa, I W. 2010. Peran Ganda Subak untuk Pertanian Berkelanjutan Di Provinsi Bali. *AGRISEP* **9**(2): 153 -165.

[13] Diarta, I.K.S. dan I M. Sarjana. 2018. Strategi Pengembangan Subak Padanggalak Sebagai Daya Tarik Wisata Di Kota Denpasar Bali (Subak Padanggalak Development Strategy as Tourism Attraction in Denpasar City Bali). *Media Konservasi* **23**(3): 281-292.

[14] Indriani, M.N., I A.P.S. Mahapatni, I N. S. Widnyana, dan I P. Laintarawan. 2019. Jaringan Irigasi Subak di Kota Denpasar. *Jurnal Sewaka Bhakti* **2** (1): 35-51.

[15] W. Windia. 2006. *Transformasi Sistem Irigasi Subak yang Berlandaskan Tri Hita Karana.* Denpasar: Pustaka Bali Post

[16] Sedana, G. and I N.D. Astawa, 2018. Institutional Adjustment of Subak (Traditional Irrigation System) Orienting Business: Case of Cooperative of Subak Guama, Bali Province, Indonesia. *International Journal of Current Research* **10**(6): 70418-70423.

[17] Yusmita, W., I G. S. A. Putra, I W. Budiasa. 2017. Manajemen Irigasi Tradisional pada Sistem Subak Umaya di Desa Talibeng Kecamatan Sidemen Kabupaten Karangasem. *Jurnal Agribisnis dan Agrowisata* **6**(2): 179-189.

[18] Andika, I P.T. W. Sudarta, A.A.A W. Sawitri. 2017. Pengetahuan dan Penerapan Tri Hita Karana dalam Subak untuk Menunjang Pertanian Tanaman Pangan Berkelanjutan (Kasus Subak Mungkagan, Desa Sembung, Kecamatan Mengwi, Kabupaten Badung). *Jurnal Agribisnis dan Agrowisata* **6**(2): 211-220.

[19] Sedana, G. 2020. Pengembangan Koperasi Subak: Kasus Subak Guama di Kabupaten Tabanan, Provinsi Bali. *Jurnal Agribisnis dan Agrowisata* **9**(3): 394-403.
[20] Yekti. M.I. 2017. Development of Subak irrigation schemes: learning from experiences of ancient Subak schemes for participatory irrigation system management in Bali. *Dalam Role of Reservoir Operation in Sustainable Water Supply to Subak Irrigation Schemes in Yeh Ho River Basin.* London: CRC Press.
[21] Sedana, G. and I N.D. Astawa, 2019. Establishment of inclusive business on coffee production in Bali province: lesson from the coffee development project in Nusa Tenggara Timur province, Indonesia. *Asian Journal of Agriculture and rural Development* **9** (1): 111-122.
[22] Sedana, G. 2020. *Cahaya Korek Api : Gagasan Membangun Pertanian.* Denpasar: Pustaka Larasan.