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ROLES OF TRADITIONAL IRRIGATION SYSTEM IN SUPPORTING RICE FARMING DEVELOPMENT: Lessons Learned from Bali Province, Indonesia

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ABSTRACT

Agricultural development has still had significant roles on economic development in Indonesia. Rice farming is addressed to increase the productivity and quality of product by using improved agricultural practices including irrigation water management. In Bali province (Indonesia), the existence of *subak* as traditional irrigation system with socio-agrarian-religious in nature, could be a one of the local cultural institutions for supporting government in the food security program. The main functions of *subak* are distributing and allocating irrigation water among the *subak*'s members and between or among the subaks which are getting water from the separated dams on a similar river. These functions are supported by the implementation of internal by-laws own by each subak governing the mechanism of planting schedule, cropping patterns, water borrowing, including ritual ceremonies conducted in the relation to phases of rice planting. *Subak* system as social capital, therefore, could ensure the availability of irrigation water over the year. Thus, the rice farming development programmed by government could be achived by the effective *subak* system.

Keywords: *Subak, Irrigation, Food Security, Water Distribution and Allocation*

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1. INTRODUCTION

Agricultural development constitutes a main sector in economic development for the developing countries which generates food, employment and income (Johnston and Mellor, 1961; Ranis et al 1990; Delgado et al, 1994; Timmer, 1995; Holcer, et al., 2013). Most of population's food is still dependent on the production from the small holder farmers (Stanton, 2000). Presently, developing countries have still strongly focused on the acceleration of agricultural development and stimulated agricultural productivity in order to achieve food security (Maiangwa, et.al., 2010; Venkatesan, 2016). It is also noted that rice farming has played very strategic role in providing food consumption of the households (Suroso, 2001). Producing more food with a certain strategy is very important to meet the global demand of people toward the food (Gani and Biman, 2007; Capone, et.al., 2014; Godfray, et.al.,2010). The needs for efficient operation and maintenance and technique on irrigation system are very importance to fulfil food demand which has increase year by year (Dabour, 2002; Nkambule and Cliff, 2013). Better agricultural irrigation has significant influenced to the increase of crop yield and and reduction of in rural areas (Cel and Kaushik, 2003; Huang et al. 2006; Mihailovic, et.al., 2014).

Implementation of agricultural development, particularly on rice farming in

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Bali province, Indonesia, has been conducted by farmers' organization called *subak*. The existence of *subak*(s), therefore, has still significantly played a great role in supporting agricultural development on rice field (Sedana, et al, 2012; Dewi, et.al. 2014). Aside from this, cultural aspect on *subak* has become a buffer for Balinese culture as an interesting factor for supporting tourism development.

Irrigation water as one of important thing for rice farming has been a problem for water users associations concerning the scarce of irrigation availability and its worse quality. On the other hand, the government has still expected farmers to be able to improve irrigation water management and increase cropping intensity for supporting the government program, food security program. In case of Bali province, the presence of *subak* is needed to have good management in water distribution and allocation with its local wisdom for producing rice. *Subak* is not only an institution in agriculture, but also as a part of Bali's local wisdom about human society and its relationship with the environment. Subak is a customary community that has the characteristics of socio-religious-agriculture, which represents farmers' associations that manage an irrigation system on rice fields. Regarding this condition, objectives of this paper is to describe socio-cultural aspects of subak as traditional irrigation system; and to understand the roles of subak in supporting rice self-sufficiency program in Indonesia.

2. RESULT AND DISCUSSION

2.1 Subak as a Traditional Irrigation System

Bali as an international tourism destination, the growth of economic development brought about some problems on *subak* system, such as water uses competition and land (rice field) conversion. Competition in using water has been felt by *subak* since the irrigation water source was also extracted by the other sectors for domestic water and industry uses. Water availability has become scarce for irrigation, thus cropping intensity is decrease. Land conversion is also difficult to control as the high need of land for housing, physical infrastructure and industry in line with economic development, such as tourism development. One of the consequecies is rice field becomes decreased which bring about the lower supply of rice (Nurliani and Ida, 2016). In Yogyakarta province (Indonesia), the impact of agricultural land conversion is directly or indirectly making poor quality and condition the physical, social and economic aspects for the people and the environment (Harini, et.al. 2012).

Rice is a stapple food for the big population of Indonesian, in which its demand has become higher every year. In Indonesia, agricultural development could not be separated with rural development since they support each other. Agricultural development, particularly on rice field (*sawah*) has significant roles on national economic development because rice constitutes a staple food. Since the beginning of New Order era, government had increased the particular agricultural program for achieving rice self-sufficiency which was finally gained in 1984. Nowadays, the national demand of rice has been increased and even it bigger than the production at the national level, in which this had been caused by land conversion (Nurliani and Ida, 2016). Conversion of agricultural land is very hard to stop in line with the increase of demand of land. It has resulted in making import policy on rice by government to ensure the food security in the country. In order to solve the unsecurity food and import problem, the government has intensively improved rice productivity through food security program. The rice Intensification by applying good agricultural practices supported by other related sectors, such as

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irrigation development, agro-inputs provision, credit, etc.

Water is one of the most important natural resources that is being used for agricultural and non-agricultural sectors. Presently, scarcity and competition of water have increasingly happened in the world including Indonesia. In Bali province, for instance, these frequently make conflicts among the users, such as *subak*, private sectors (for tourism and industry), and government (for domestic water), particularly along the water source (river). *Subak* as an organization that regulates the distribution of water in the rice field is one of Bali's cultural heritage that has been recognized worldwide (Aryawan, et.al., 2013). *Subak* is a widely known 'traditional' irrigation management institution for rice cultivation in Bali which has been established since thousands ago (Purwita, 1999; Sedana, 2012). It has developed over the centuries in the specific socio-cultural, agro-ecological and political-administrative environment of this small and mountainous island (Roth and Sedana, 2015). It has been known that the subak and irrigated rice agriculture became well adapted to, and embedded in the characteristic Balinese landscape of rugged mountains and steep valleys deeply incised by fast-flowing rivers.

In the past, the kings (monarchy) involved in *subak* system by allowing farmers' group to construct temporary dams on the rivers to irrigate the existence dry land. Even, the Monarchy gave freely some land taxes for the farmers. In the period of the Dutch administration, the head of *subak* was instructed to collect land tax from the farmers (*subak* members). It is worthy to note that subak has specific activity--ritual ceremonies related to irrigation and rice farming system which might not be found in other irrigation systems in Indonesia (even in the world). The philosophy of the *subak* system is *Tri Hita Karana* (three causes of happiness) concept based on the harmony among the three. Tri Hita Karana is a universal concept of harmony and togetherness (Windia, 2010). The fast growth of development in Bali, however, has brought about the increase of land converse. The competition of water also becomes complex due to water for non-agricultural purposes increase. This is a major threat to the subak sustainability in Bali. Subak must be revitalized in anticipating the challenges (Sutawan, 2005).

Susanto, et al (1999) cited that *subak* is water user association in Bali which has some characteristics in the relation to irrigation, agriculture and culture. *Subak* has a complete independence from the village administration because of its autonomy with the rule and regulations where the members are subject to comply. Culturally, the activities of *subak* are strongly related to socio-cultural life of the Balinese Hindu society. The affiliation factors of *subak*s' members are water and temple. In general, *subak* has five functions, namely: (i) to equitably distribute and allocate irrigation water to the members, (ii) to conduct operation and maintenance of irrigation system, (iii) to create fund raising; (iv) to manage conflicts among members, and (v) to perform ritual activities. The latest function--ritual activity is done based on the phases of rice growth starting from getting water, land preparation, seedlings, transplanting till harvesting. For the subak, ritual ceremony is a power for farming and irrigation activities on rice field.

Management of subak is very simple which is chaired by a head of subak, called pekaseh elected democratically by all members. Pekaseh is assisted by secretary and treasurer in implementing administration aspects. In the larger size of subak, there might be elected a head of sub-subak coordinating the activities in each sub-subak. The organizational structure of subak is show in Figure 1.

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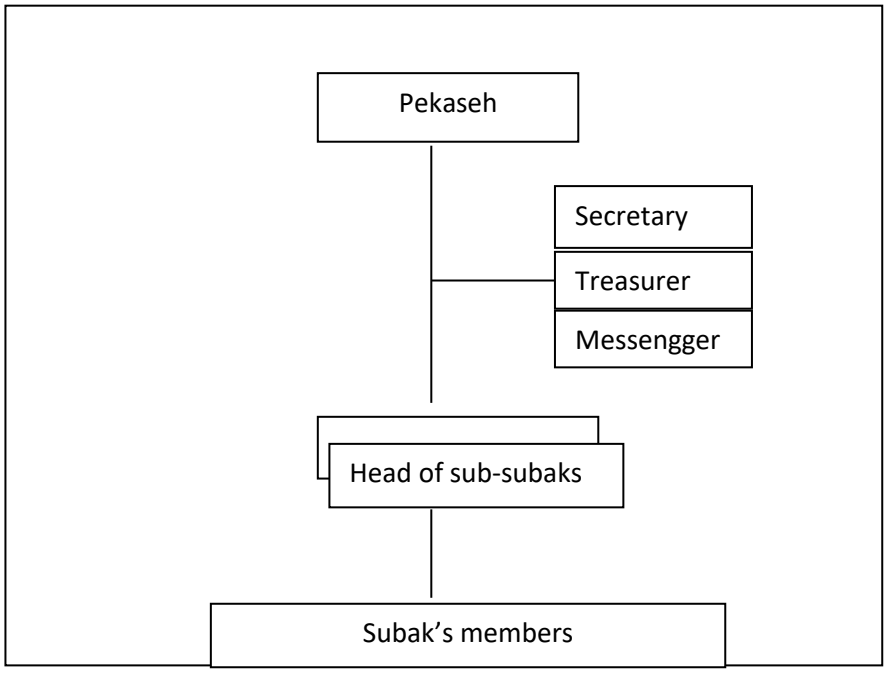

Fig. 1 Organizational structure of Subak

The subak system as an organization has a variety of roles and functions (multi - functional roles), which is not merely to produce food. Several functions of subak on irrigated land are as follows: production and economic funsctions to ensure food security; environmental functions including flood control and erosion control, groundwater recharge; purification of air and water; and giving cool air; ecological function (as an habitus for various species that provide a source of protein for farmers and preservation of biological diversity. It also has social and cultural functions, namely as buffer of rural tradition and social-cultural values; rural development functions, which is the source of drinking water for livestock, washing and bathing for the villagers, providing employment opportunities for the villagers (Sutawan, 2002; Groenfeldt, 2006). In terms of tourism aspects, subak also has ecotourism and agrotourism functions because of the attractiveness of scenic beauty in the form of rice terraces and natural rural and agricultural life of the rural population including agricultural production (Lorenzen, 2011; Mizutani, 2002; Shah and Shah, 1994). At subak level, there are some roles that should be done for achieving the goals of subak members and suppoting the above mentioned functions. These are: distribution and allocation of irrigation water; mobilization of resources for operation and maintenance of irrigation facilities; fund raising, conflict management; and ritual activities.

Water distribution and allocation is the primary function for binding the farmers in farming activities within Subak system. The division and allocation of irrigation water is done from the source at the river through weir to the farm level at the rice fields. At the weir level, for example, the water is proportionally divided to a subak and other subaks located at the downstream area. Before government's intervention, the subaks along the river had a consessus to divide allocation of water among themselve. Informally, they had coordination

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for water distribution, allocation including water control.

At the river level, water distribution system is done through an agreement among subak that utilize water. In case of singular subak having some sub-subak called tempek, water distribution was done under various systems based on the subak consensus (Sushila, 1991). There are continuous, rotation and stragering system. During dry season, water distributon is run on the continuous system. In dry season, however, the system might be rotation and stragering. The subak should manage water uses for planting rice and secondary crops called palawija based on the availability of water at the source level or river. By subak system, it is fully allowed among the members to have mutual water borrowing in order to overcome scarcity of water. It is sometimes done by stagering system. There is interval period time for a number of farmers to cultivate their land earlier than the others. One the earlier farmers completed their land preparation, the water should be distributed to other farmers. Allocation of water is managed by using traditional measurement, called *tektek* or *depuk,* or *nyari* dependent on the locations where the subak are. These are found on the division structures at tertiary system. *Tektek,* or *depuk,* or *nyari* is a concept to allocate water to each subak members (farmers) proportionally, based on the wide of existing canal, where the water division is constructed (Roth, 2011).

In case of plural subaks (some subaks get water from a weir), water distribution is divided in the division structure. There is coordination between or among subaks for water distribution and allocation. In some irrigation networks under PU, government officer is the one who operate the water gate constructed on the water division structure. In order to have good water distribution and allocation, the subaks might establish coordination body called subak-gede (Windia, 2010). At the broader level, subaks getting water from one river might establish a federation of subaks called subak-agung (Sutawan, et al., 1995).

Mobilization of resources is very important activities within subak system, particularly for operation and maintenance of irrigation facilities. Mobilization of resources is in the forms of physical and non-physical things. Physical forms needed are labor of farmers for the rehabiitation and upgrading of irrigation facilities through the mutual works called *gotong royong.* They also contribute cash money for buying materials. While non-physical forms are the ideas contributed by farmers shared within a meeting or sangkepan.
Fund is one of the important components in organizing the activities of an organization including subak. A fund in each subak is used to finance the operation and maintenance of irrigation facilities and other activities such as ritual ceremonies. In the financial aspect, subak manages several things that must be well known by all members. These are: the reason of money collected, the amount of money contributed, technique for mone collection, uses of money collected, and accountability of money uses.

In some subaks, there are some sources of subak revenue, such as *sarin tahun*, the dues charged to all members after the rice harvest; *pengampel*, the fees charged to the subak members who are not active; gegadon, which dues charged to members of the subak rice growing season after kerta masa (rice planting within rainy season); auction, which is derived from dues payments made for example for rearing duck or planting tobacco after harvesting; fines, which is a payments made to members who violate the rules or other agreements of subak. Nowadays, subaks also get a source of revenue from the economic activities related to agricultural development, such as cooperative unit established under subak system, such as in Guama and

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Selanbawak subaks (Sedana, 2013) and grant from government.

Conflict among members of subak is managed by subak itself through the subak meeting. Kind of conflicts are water stealing, planting beyond the schedule, absence in the certain subak activities, and others. Conflict is also found in water distribution among subaks which have water from one source. The existence of coordination body inter-subaks is also needed for solving the problem of water distribution (Sutawan, 2000). Recently, the conflict of water is also found between subak and other sectors, such as industry. There is a complex need of water at the source level wherein the water availability is scarcer. The use of water by industry could decrease the water supply for subak. For this problem, subaks getting water from the same river should establish federation of subaks.

Ritual activity is one of the principal activities of the subaks in Bali and makes subak is very specific cultural organization (Lansing, 2005). There are many sequent ritual activities performed by subak startting from fetching water in the weir, preparing the land until harvesting). Ritual activity of subak refers to the philosophy of *Tri Hita Karana* (three causes of happiness) which consists of three elements, namely *Parhyangan* (the relationship between man and God), *Pawongan* (the relationship among the members and outsiders), and *Palemahan* (the relationship between humans and their environment). Implementation of ritual activities is done at several levels, i.e. the level of individual farmers (in *ulun carik* temple), the level of subak (bedugul temple, temple of ulun suwi, ulun empelan temple, and others , and the level of inter-subak (ulun suwi temple and ulun danu temple). The existence of subak-gede and subak-agung is very important to manage the activities of ritual works.

Coordination body and federation of subaks might have significant roles in supporting the dam development. At least, they give information about the existing water management (distribution and allocation including ritual activities) along the river. It is noteworthy that coordination body of subaks and federation of subaks have some functions, as follows:

1. To coordinate the water distribution and allocation among the subaks
2. To coordinate the planting pattern, planting schedule
3. To coordinate resources mobilization
4. To coordinate ritual activities at the higher level
5. To liason subaks with the outsiders
6. To communicate subaks concern to government and other sectors

Roles of subak-gede and subak-agung might be useful in making beter decision for the government and the implementor of projects (contractor). Negative impacts might be minimized and bring about the maximum benefits for subaks asides from for the other sectors.

In order to support rice farming development in Indonesia, subak should be created an economic incentive needed by farmers and their family in order that they keep working on rice field farming. Agribusiness is one of the approaches to sustain their farming on rice field. Agribusiness is defined as “the sum total of all operations involved in the manufacture and distribution of farm supplies; production operations of the farm; and the storage, processing, and distribution of farm commodities made from them” (Davis and Goldberg, 1957,). Agribusiness could be seen from various ways dependent on the view of point. It might talk about agro-industrialization (Boehlje 1999; Cook and Chaddad 2000), or value chains (Lazzarini, Chaddad, and Cook, 2001). Based on definition cited, agribusiness emphasizes the interdependence concept of various sub-system within the agribusiness itself, starting from supplying agro inputs, on

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farm, processing and marketing or distributing produces (Soekartawi, 2005).

Economic incentive needed by farmers and their family should be available for keeping them to work on rice field farming. Agribusiness is one of the approaches to sustain their farming on rice field. This approach might be done by defining a business model for the actors involved within the business model, such as farmers and *subak*, company (as a partner) and local bank (as a supporting partner). These actors must have interrelated partnership in implementing market system under the business model defined in order that they could gain proportionally benefit and profit. The assumption is private sector (companies) would be preferred to work with organized farmers (subak) rather than individuals. The business model might be a guide for the actors to sustain economic activities (see Figure 2).

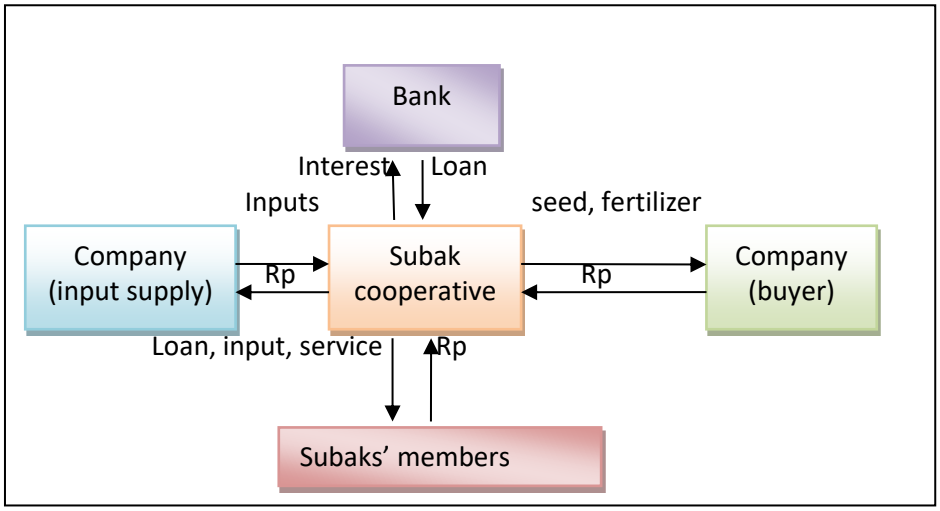

Fig. 2 Business model

In this model, subak should be organized to improve the quality and quantity of rice production as a crucial to the sustainability. Subak cooperatives establishment is very important in making greater role in the value chain within a business model. In case of Subak Guama (in Tabanan regency, Bali province), subak formed cooperative which has some economic activities (Sedana, 2013). The activities are producing rice seed, micro credit, integrated crop management, crop livestock system, providing agro-inputs and others. Cooperative formed could assist useful linkages between smallholders and other actors in the value chain. Referring the business model, farmers could have easier access to finance and information or technologies about good agricultural practices. Aside from this, it could make stronger bargaining power in selling produce. It looks that there is a structural transformation in the rice farming development. There is a sustainable change from subsistence to a productive orientation that allows farmers to take part in the market.

Cooperative gets agro inputs from the companies, such as fertilizer, pesticide and other small equipment needed by farmers for their rice farming activities. There is a contract between cooperative and company for retailing agro inputs. Based on package of technology, farmers get agro input in line with the land size. Payment of inputs could be done after harvesting. In running agribusiness activities, subak still employ its bylaws, called *awig-awig* to control farmers and management board. Even though cooperative runs it activity under the modern management, traditional management of subak is still there.

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There is a consensus that the profit of cooperative must be shared to subak, especially for social and ritual activities (Sedana, 2013). This benefit is very useful for farmers as subaks' member since they might not contribute cash money for such social and ritual activities. At the individual farmer level, all farmers get services from cooperative in form of loan and technical assistance on agricultural rice farming. Improved technologies applied by farmers bring about higher productivity and income. Having good business model with the proportional economic profit for each actors will ensure the sustainable partnership among them in the rice farming business. Specifically at the farmer level, the farmers might still have good interest to work on their rice fields, thus they might not sell the land. In other side, physical development such as dam construction and its facilities should be followed by the intensive program on agricultural development by government, particularly in term of productivity improvement. The presence of agricultural extension workers is very important to disseminate technologies or good agricultural practices to farmers through their groups for making good income for farmers (Anderson and Feder, 2004). Agricultural extension is addressed to improve the knowledge, attitude and skill of farmers in applying technology, such as seed selection, using fertilizer, irrigating, etc. In some countries including Indonesia, farmers have still used limited agroinputs (improved seed and fertilizer) which bring about low yield (Ali and Pitkin, 1991).

2.2 Government Interventions in Subak System

In the implementation of agricultural development program in term of rice farming, government agents always coordinate with the chairman of subak (*pekaseh*) in order to make easier and faster the diffusion of innovation. Since the green revolution program introduced by government, the subaks have been intensively involved in the program. The application of new practices on rice farming will be effective through subak system. Subak will make a decision under the subak meeting in the relation to selection of variety, cropping pattern, planting schedule and others. Introduction of commercial farm has been developed by the extension agents in order that farmers might have higher income gained from rice farming. The higher income could be an incentive for farmers to intensively work on their rice filed. Thus, land conversion might be control or minimized.

After intervention of government, particularly in constructing the irrigation facilities (weir, canal, division structure) and regulations, there are some changes on subak system. Operation and maintenance of irrigation system has been changed. Distribution and allocation of water was done by the government officer. They set water meter control device and put a water gate to up and down control and sedimentation flow control. Under the national regulation, operations and maintenance works at the primary level icluding at the weir are under government officials. Previously subak run operation and maintenance for all level (primary, secondary and tertiary system). After government intervention, the subak has responsibility only at the tertiary level or farm level.

Nowadyas, government has been increased its development to support food safety by constructing the dam and other water supply or reservoir in Bali. This is aimed at storing excess water during rainy season that can be used to water supply and water resources at a time required, agricultural needs as well as flood control, water quality, sediment control and energy or hydropower. Dam or reservoir is very important to be constructed for storing water during periods of surplus water availability. During the the water availability is scarce, dam could conserve the same for

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utilization. Dam or reservoirs constructed is useful for agricultural needs because water flows can be regulated as per agricultural requirements of the various regions over the year. Floods in the rivers could be also controlled by constructing the dam or reservoir.

Construction a new dam or reservoir sometimes brought about the problems among the subaks especially on the water distribution and allocation and operation and maintenance works. Subaks along the river historically have informal coordination among themselves. Hidrolically, they relate to each other. Therefore, before the implementation of dam or reservoir construction, there must be done socialization for the entire subak in order to avoid the problems. Ambler (1990) said that the management of subak organization is not merely about irrigation water and technical aspects but also relates to socio-cultural aspects. Rachman (2009) revealed that in an effort to create the management of water resources in an efficient and equitable allocation, the necessary institutional adjustments is needed. Subak as regarded as social capital with its local values and knowledge in terms of rice farming and is able to support the increase of rice productivity (Sedana, et.al. 2014).

Several factors must been considered by the government before the construction of dam. There are site selection, technical feasibility, location of water deficit regions that need to be serviced and alternatives available for the purpose. Aside from these, it should be calculate the advantages and disadvantages of the dam, especially in socioeconomic and environmental aspects. Construction of dam on the river should fully consider the other aspects of community such as subaks which utilize water from the river. Water resources projects in Zimbabwe such as dams represent large-scale engineering works that might bring about significant impacts on socio-economic components of the environment (Mudzengi, 2012).

In term subaks, development of dam or reservoir must bring benefit in supplying irrigation water. As the primary indicator for this benefit is crop intensity on the ricefield.

Irrigation stabilizes crop production, improves crop quality, reduces rural poverty, and allows for diversification in farm production (Kai, et.al., 2006). Subaks principally have a good management in planting rice, such as variety selection, planting schedule, planting pattern and others. Therefore, it must be clear information about the condition of water availability after dam construction.

Government must involve the subaks that might get the impacts from development of dam or reservoir. It means that an assessment of the socio-economic impacts of the construction of a dam must be carefuly done, particulalrly in the aspects of irrigation water and agro-economic of farmers. Participatory approach is very important to conduct in the project development starting from the prepararion, planning until the monitoring and evaluation of project. The involvement of subak is needed because subak is farmers‟ institution having complete rules and regulations where the members are subject to comply; subak has capabilities to mobilize and manage the available local resources; and subak activities are related to socio-cultural life of local community in Bali (Susanto, et.al. 1999).

3. CONCLUSION

Subaks have significant roles in water management within subak level and inter-subaks level. Philosophy of Tri Hita Karana is always being a guide of subaks in irrigation management, especially in running their functions. The functions of subaks are distribution and allocation of irrigation water; mobilization of resources for operation and maintenance of irrigation facilities; fund

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raising, conflict management; and ritual activities. Government has been increased its development to support food safety by constructing the dam or reservoir in Bali in order to store excess water during rainy season that can be used to water supply, agricultural needs and other functions. Subaks should be strengthened its capacity in terms of technical, socio-cultural, economic, agricultural, irrigation and management aspects to make higher productivity of rice.

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