Scaling out integrated village management systems to improve Bali cattle productivity under small scale production systems in Lombok, Indonesia

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Scaling out integrated village management systems to improve Bali cattle productivity under small scale production systems in Lombok, Indonesia

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Abstract

This paper discusses results of an adaptive study to scale out an integrated village management system (IVMS), which successfully improved Bali cattle productivity (Panjaitan et al 2008) in 36 farmer groups involving more than 1000 farmers in Central Lombok eastern Indonesia. The IVMS was communicated to farmers by 12 well trained on ground team members (OGTs) using a farmer to farmer approach. The results show that the IVMS was successfully scaled out to a wider farming community in Central Lombok with a similar increase in cattle productivity as reported by Panjaitan et al (2008). Productivity of Bali cattle under small holder conditions can be more than doubled by improving the supply and quality of nutrients according to the physiological status of the animals and by improving housing/hygiene. Despite a significant increase in cattle productivity, the cattle population in the study area did not increase due to limited access to land (for housing and to produce forages). However, the increase in turn off rate has been considerably high. The key to this successful scale out was the continuous facilitation by the OGTs to stimulate collective actions in order to improve farmer capacity to adopt improved management concepts. Sustainability of this system has been constrained by lack of continuous facilitation and by programs that discourage farmer participation.

Keywords: *calving rate, growth rate, mortality rate, strategic feeding, weaning weight*

Introduction

West Nusa Tenggara Province (NTB) of eastern Indonesia consists of two main islands i.e. Lombok and Sumbawa. This province is a major supplier of cattle in Indonesia. Dahlanuddin et al (2008) reported that the cattle production system on Lombok is predominantly semi-intensive and small-scale, with cattle often reared in communal structures (kandangs). Communal kandangs originally emerged as a strategy to protect against cattle theft, with members taking turns to watch over cattle at night. Kandangs

are now associated with farmer groups, though the functionality of groups varies significantly, some formed simply to access subsidized inputs from the government with little other activity. In the mid 2000s, there were approximately 800 farmer groups associated with the collective cattle housing system, with the number of farmers ranging from 10 to 20 and the number of cattle from 18 to 66 head of cattle in each group.

The main constraints to improving Bali cattle (*Bos javanicus*) productivity in eastern Indonesia are low calving rate (52%), high calf mortality (15%) and low birth weight (12.7kg) that leads to low weaning weight (Talib et al 2003). The post weaning growth is also very low at 0.2 kg/d (Dahlanuddin et al 2012) resulting in low overall herd productivity.

Improving cattle productivity in the smallholder system has been difficult due to the limited resources available to individual smallholder farmers to implement technology. Collective action, involving group management of key resources to implement practices is thus recommended to improve the uptake of new practices by farmers.

An Integrated Village Management System (IVMS, detailed below) has been reported to significantly increase calving rate, reduce calf mortality and increase weaning liveweight of Bali cattle under a collective housing system in Kelebuh village, Central Lombok (Panjaitan et al 2008). Dahlanuddin et al (2012) demonstrated that the growth rate of newly weaned Bali calves can be increased from 0.2 kg/d to 0.38 kg/d by including fresh *Sesbania grandiflora* in the diet at approximately 30%.

IVMS practices were developed, tested and adapted in participation with farmers in both individual and collective systems between 2001-2006 (Panjaitan et al 2008; Lisson et al 2010). An adaptive research project was carried out from 2007 to 2010 to scale out these improved management strategies from only one farmer group to 36 farmer groups involving about 1200 farmers in Central Lombok district, NTB. This paper discusses the scale out processes and its impact on Bali cattle productivity, and household livelihood.

Materials and methods

The intervention package scaled out in this study was an IVMS consisting of:

a. controlled mating with a community-selected bull from June to December (dry season) to enable peak calving to occur during March to June when feeds are in good supply and of reasonable quality
b. mating of cows 40-60 days after calving to enable the cow to get pregnant within 60 days after calving,
c. mating heifers at 18 months of age or 180 kg live weight,
d. weaning calves at 6 months of age to minimise nutritional burden of the cow,
e. feeding high protein and high energy feeds to cows during late pregnancy and lactation,
f. improving supply of high quality forages by introducing improved forages and locally available high quality forages, and
g. participatory group action to improve animal housing and hygiene.

The IVMS was communicated using a systems approach. The approach takes into account all aspects of beef cattle production systems beyond the technology aspect (e.g. available land, labour and financial resources). Twelve On Ground Team members (OGTs) were selected, trained and mentored to enable them to communicate the IVMS,

facilitate and support farmers in trialing and adjusting the system to suit their conditions, and collect necessary data to measure progress. In the first year, 23 new farmer groups were selected to learn about the IVMS package. They were supported by the OGTs, and also through farmer to farmer learning process via an established farmer group at Kelebuh village, Central Lombok. The capacity of these farmer groups to implement the IVMS was then improved by regular training and discussion with the OGTs and cross visits to other farmer groups. In the second year, another 12 farmer groups were selected and engaged with the project so by the beginning of year two there were a total of 36 farmer groups and each OGT member was responsible for three farmer groups.

The project provided one bull to each farmer group in their first year to be used for mating during June to December of that year. As the price of bulls increase each year all farmer groups were asked to arrange a mechanism to sustain the bull without additional funding from the project.

The OGTs were trained by a Project Specialist Team (PST) consisting of Australian and Indonesian experts specializing in cattle nutrition, reproduction and health, socio economics and communication. The OGTs spent Monday to Friday working with farmers and collecting data, then attended a weekly meeting on Saturdays with Specialist Team members to discuss weekly achievements and concerns and to provide mentoring and training on a flexible and adaptive basis.

Data collected by OGTs included individual farmer and farmer group profiles and cattle data (mating date, calving date, calf birth weight, calf mortality and calf weaning weight). Data on cattle condition, cattle sale and household herd size were also collected.

Implementation of some of the IVMS practices was essentially driven by the farmer group as a starting point for participation in the project. However, introduction of a project bull (and the means to sustainably manage it) and starter funds to improve infrastructure led to all farmer groups trialing controlled, natural mating and all farmer groups improving communal housing and hygiene.

The timing of mating and weaning and preferential feeding were individual farmer decisions, and forage production was governed largely by the individual farmer (if she or he had access to land for forage production) and partly by the group (in areas with less available land, communal activities were necessary and more common).

Results

Collective actions to facilitate technology adoption

Improvement in pen facilities

One of the constraints of the smallholder farmers to adopt an improved management system is the lack of capacity of individual farmers to renovate pens (roof, floor, mating space, etc), improve feed troughs, and improve pen drainage. A participatory, communal approach was taken to improve housing condition by providing a small amount of stimulant funds to each group to be used on whatever the group felt was the biggest infrastructure constraint. Farmers were then encouraged to contribute cash or labour to match the stimulant funds and the majority of groups did this successfully (Figure 1).

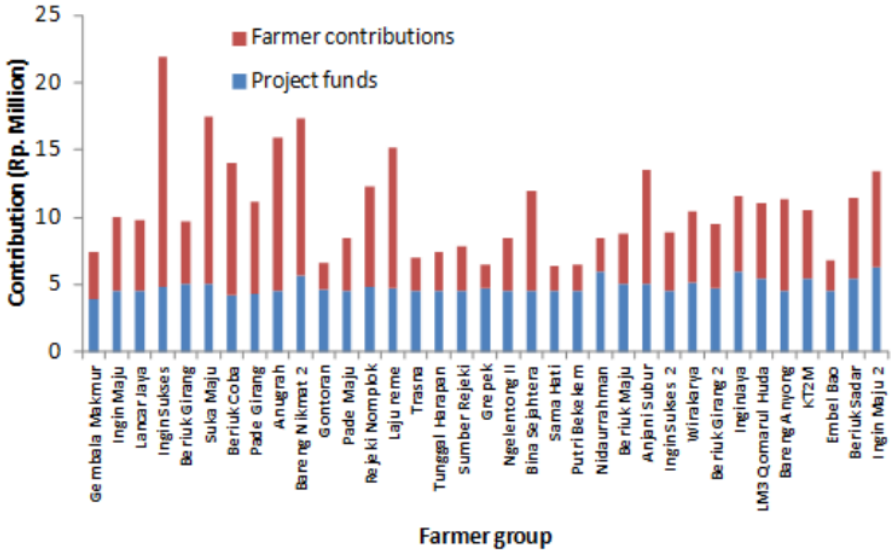

Figure 1. Estimated financial contributions of farmers to improve facilities of the collective housing to enable implementation of IVMS.

Renovations of the pens included:

a. improvement in the floor and drainage system to facilitate effective removal of urine and faeces
b. improvement of the roof to protect the cattle from hot sun and rains
c. establishment of a mating pen where the selected bull was housed to stimulate oestrous and to facilitate controlled mating
d. establishment of a feed trough in each pen to facilitate feeding improvement
e. establishment of a crush and weighing platform to enable regular weighing of cattle.

As demonstrated in Figure 1, all farmer groups contributed a considerable amount of funds on top of the amount provided by the project. Many groups invested more than double the amount of project funds by encouraging contributions from group members in the form of cash, building materials and labor.

Bull management

The bulls provided by the project were selected together by the project team and representatives of the farmer groups. The bulls were selected by a set of criteria agreed by the project team and the farmers. These criteria included coat color (to match the coat description of mature male Bali cattle), general health condition, body conformation, scrotal circumference and some traditional traits such as shape of the horn, length of the tail and temperament.

Funds for the bulls were provided by the project in the first year only. The price of bulls increased each year. In most of the participating farmer groups, a micro finance system was established to generate additional funds to sustain the bulls. A 'bull keeper' was democratically selected in each group to be responsible for feeding and care of the bull during the mating season. A mating fee for every cow successfully mated was determined in a group meeting (typically Rp 15,000 per mating for group members, and Rp. 25,000 per mating for non group members). The bull keeper received up to 70% of the mating fees and the remaining funds were retained by the group. At the end of the mating season, the bull was sold and up to 70% of the profit went to the bull keeper and

the rest of the funds were returned to the group saving account. Group funds were lent to group members at an agreed interest rate, to be paid back to the group before the mating season started again.

Figure 2 illustrates the number of cows mated in each group from June to December 2009. The numbers include cows belonging to group members and cows from farmers in surrounding areas (satellite farmers). The satellite farmers came to mate their cows at nearby project sites because they did not have their own bull and because they heard from participating farmers that the project bull could improve the genotype of the calves.

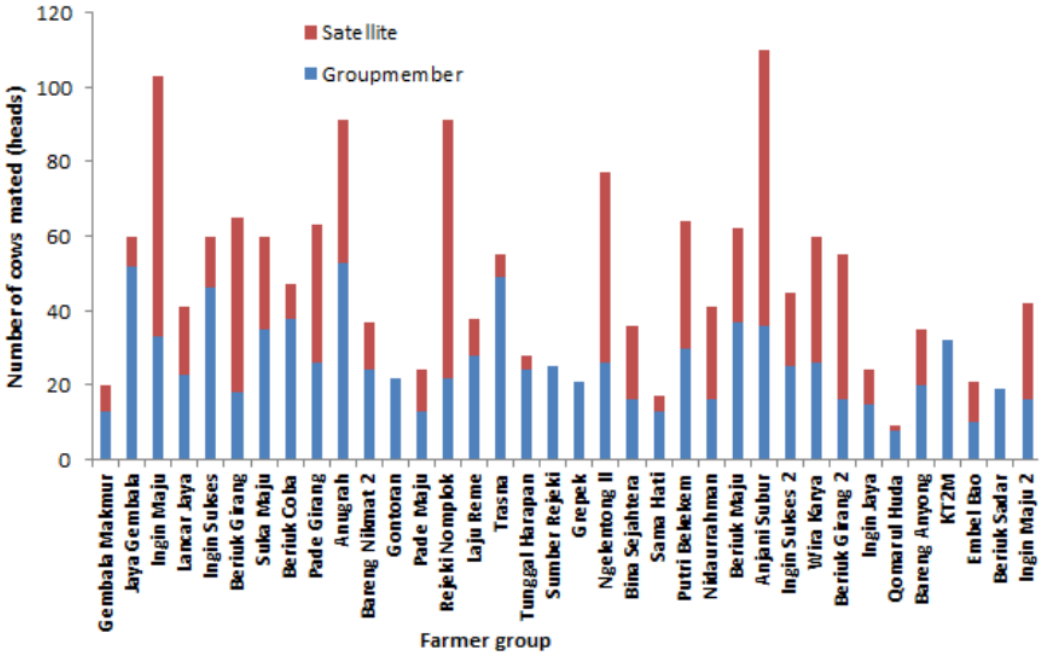

Figure 2. Number of cows successfully mated with the selected bull within the mating season (note: the number of matings was
limited by the number of cows in each group and in the satellite area, not by the mating capacity of the bull).

Previously, farmers believed that one bull could mate with a maximum of 20 cows. In some of the farmer groups, the selected project bull mated with 50 or more cows during the mating season. There was also a general belief that if a bull is used to mate cows too frequently, then the bull will not put on weight. In fact, all project bulls gained weight and were sold at a competitive price, and considerable profit, at the end of the mating period.

Adoption of IVMS components

The most commonly adopted component of the IVMS was controlled mating with a selected bull at 40-60 days after calving (73.1% of farmers). This was followed by feeding high quality feed to cows during late pregnancy (66.4%), weaning calves at 6 months of age (60.3%), feeding high quality feeds to cows during lactation (41.9%), better feed for newly weaned calves (38.4%), planting and use of improved forages (34.5%) and mating heifers at 180 kg (12.8% of farmers).

The high adoption rate of mating cows from 40-60 days after calving was due to the

availability of a selected bull in the collective housing system and the improved mating performance of the bull. Farmers observed that the selected bull had a high mating load, had a much higher success rate compared to artificial mating and may improve the phenotype of the offspring. This is in accordance with Fahey et al (2000) that a selected bull can improve genetic potential of up to 150 calves through his lifetime.

Planting and use of improved forages was low because only 60% of the farmers had access to free/available land. The most common introduced forages were *Brachiaria brizantha* x *ruziziensis* (cv. Mulato) and *Panicum maximum* (cv. Simuang). Mulato and Simuang are now widely distributed throughout the area. Grasses are preferred over the introduced legumes (*Centrosema pascuorum*, *Stylosanthes guyanensis* and *Clitoria ternatea*) because these legumes rely on seeds to be multiplied while grasses can be multiplied by vegetative transplant. Improved forages were mostly planted on bunds surrounding the rice field. These modest plantings are not able to account for all feed requirements, however farmers reported forage plots, especially near the home, helped relieve pressure on the household during times when the farmer was not able to spend time undertaking cut and carry activities (eg. during peak farming periods or due to illness).

Adoption of mating heifers at 180 kg was low because not all farmers had heifers or retained female calves as replacement of breeding cows. This is because calves (males or females) are commonly sold as early as 6 months of age when farmers need cash.

Scaling out information from participating farmer groups to 'satellite' farmers (individual farmers in close proximity to the participating farmer groups, but not part of them) was not a priority for the project. However over 400 satellite farmers adopted some of the IVMS components. The provision of an effective mating service at a reasonable cost (and hence controlled mating) were the entry point. According to a survey of satellite farmers, while there was a high level of engagement with project farmers in the use and benefits of the bull, there was little additional information shared on other IVMS components, and hence only minimal adoption was noted during the project. Where additional IVMS practices had been adopted by a satellite farmer, this was often due to strong connections to a group member (eg. family or friend); a particularly active champion within the group that provided more information; and/or close proximity that allowed satellite farmers to 'be inspired' by the benefits they saw in the group.

Of note is that the average distance a satellite farmer travelled for bull services was 1km (i.e. to address their most pressing production constraint). This suggests that project influence might be felt within a 1km 'halo' from the project group, but rarely further without family or strong inter-group connections.

Improvement in cattle productivity

Improvement of calving rate, mortality rate, birth weight and weaning weight in the 36 farmer groups are presented in Table 1.

Table 1. Calving rate, calf birth weight, calf mortality rate and weaning weight of Bali cattle herd in the 36 farmer groups in Central Lombok in 2009-2010

Parameter	Baseline	Project achievement	
		Mean	Range
Calving rate (%)	51.7*	86.8	60.0 -100.0
Calf birth weight (kg)	12.7*	16.0	13.9 - 18.2
Calf mortality rate (%)	15.0*	4.8	0 - 18.5
Inter calving interval (months)	16.0*	12.4	8.3-18.4

Weaning weight at 6 months of age (kg)	70.0**	90.2	66.8 - 117.4

** Talib et al (2003); ** Panjaitan et al (2008).*

The adoption of IVMS components increased calving rate to 86.8%, increased birth weight to 16 kg, reduced calf mortality rate to 4.8%, reduced inter calving intervals to 12.4 months and increased weaning weight to 90.2 kg. The improvements in cattle productivity varied between farmer groups as indicated by the minimum and maximum values in Table 1.

Discussion

Improved access to a selected bull

Availability of a quality bull is important to a successful cow-calf system. Fahey et al (2000) suggested that effective bull selection can ensure rapid genetic improvement of a herd. One bull can influence genetic potential of up to 150 calves during his lifetime, while an individual female can improve the genetic potential of up to only 10 progeny in her lifetime.

Dahlanuddin et al (2008) reported that 200 out of 486 farmer groups in Lombok focusing on a cow-calf system do not own or have access to bulls. This is likely to have been the main cause of the reported low calving rate. Providing one selected bull for every farmer group in this project has facilitated timely mating (indicated by high percentage of cows mated 40-60 days after calving) and contributed to the subsequent increase in calving rate (87%).

It has been a general belief amongst farmers that a bull can serve a maximum of 20 cows. This study showed that a bull can serve more than 100 cows within the 6 month mating period (Figure 2) with an average bull:cow ratio of 2.1%. This bull:cow ratio is lower than the bull:cow ratio of 2.5-6% generally applied under free grazing system with shorter mating period in northern Australia (McGowan et al 2002). There was also a general belief that if a bull is used to mate the cows too frequently, then the bull will not gain liveweight. In fact, all project bulls gained liveweight and were sold at a competitive price at the end of the mating period.

Access to the selected bull was facilitated in this project by establishing collective action for managing and sustaining the bull in each farmer group. The bull management system established in this project (selection and purchase of bull, establishment of mating pen and bull keeping arrangement) ensured that the bull keeper and the group members have mutual benefit, which is an important factor for sustainability of the system.

Consistent farmer training has improved farmer knowledge on good bull management and use. The bull management system has increased the capacity of farmer groups to conduct timely mating of their cows which would not be possible without collective action. This also increased the social capital of the group in solving their problem of lack of suitable bull for mating. Patrick et al (2010) suggested that government development programs using farmer groups to increase cattle production should also aim to foster group trust and good leadership if they wish to move beyond short term smallholder welfare to better market connectivity and industry efficiency. The elevated levels of social capital are a positive indication of such a shift in the project groups.

Improved herd productivity as a result of better feeding and better management

Calving rate increased by more than 30% over the calving rate reported by Talib et al (2003). This is due to increased adoption of mating cows 40 days after calving. This result would be otherwise difficult to achieve as many of these farmer group did not have access to a suitable bull for mating prior to the project.

Improved cow nutrition, better sanitation and better management successfully reduced calf mortality to less than 5%. Calf mortality in NTB was reported to be 15% and in drier area such as West Timor, the mortality can be as high as 48% (Talib et al 2003). A related study (Dahlanuddin et al 2009) indicated that the major causes of calf mortality were sanitation related diseases such as scouring/ diarrhoea, injury or bad handling or birth issues (eg premature birth, failure to suckle after birth, still birth, swollen head, very weak at birth). The majority of calf mortality was noted in the period of 0-60 days after calving. This information suggests that calf mortality could be even lower if animal handling skills are improved and hygiene and housing conditions continue to be enhanced.

Improved mating management and better nutrition of cows, especially during late pregnancy and lactation, increased the proportion of cows returning to oestrus quickly, enabling them to be mated early and pregnant within 60 days after calving. This reduced the inter-calving interval from the 16 months commonly observed in NTB region to 12.4 months (Table 1).

Uptake of the IVMS components by farmers also increased calf weaning weight at six months of age to 90.2 kg. This is higher than the 83.9 kg weaning weight for Bali calves in NTB reported by Talib et al (2003). Further, the weaning weight reported by Talib et al (2003) may have been for a calf of more than six months of age, as there was no farmer practiced weaning of calves in the 36 farmer groups before the project started. A more recent study (Panjaitan et al 2008) reported that the weaning weight of calves in the farmer group when this IVMS was initiated (then involved in this current study) was 70 kg.

The high weaning weight for calves born in the project means that the calves had a high pre weaning average daily gain (ADG) of 0.50 kg/day. This can be attributed to improved cow nutrition and thus milk production. Imran (2013) reported that milk production in Central Lombok was 0.97 kg/day for cows fed native grass only and increased to 1.47 kg/day for cows supplemented with 30% fresh *sesbania grandiflora* during late pregnancy and during lactation. Also, Supriyadi (2015) reported a higher pre weaning ADG of 0.38 kg/day for calves from cows receiving tree legumes throughout pregnancy and lactation compared to 0.14 kg for calves from cows given king grass ad libitum through out pregnancy and lactation.

Much of the improvement in cattle production can be attributed to improved cow nutrition. These improvements include feeding sufficient quantity of feeds and feeding high quality feeds to late pregnant and lactating cows. This is made possible by improved pen condition and improved farmer understanding on how much to feed and what feed to provide to cattle in different physiological stages. Simple examples of these recommendations are for farmers to always make note of feed refusals in the trough and to feed improved grasses and/or legumes to cattle on a regular basis.

The increased turn off rate

Adoption of project practices resulted in significant increases in important productivity indicators. However, despite the significant increase in calving rate and reduction in calf

mortality, cattle population in the study area did not increase substantially (Figure 3). Herd dynamics data suggest that while herd size remained relatively stable, births and sales increased.

As a result of participation in the project, farmers were able to sell animals at a younger age due to increased liveweight gain between birth and weaning, resulting in a market-ready animal that required fewer inputs for the same financial outcome. In this way, farmers realised their objective of increasing reproductive potential and converting this to greater throughput and increased sales without overt strain on forage or housing resources.

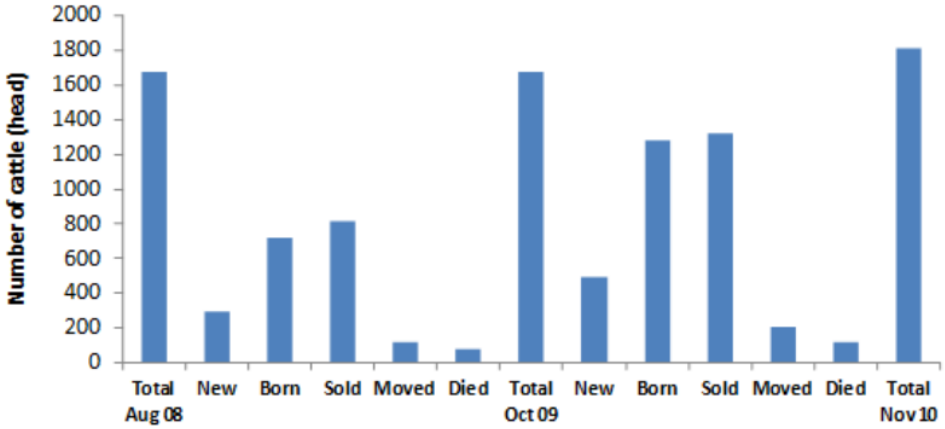

Figure 3. Herd dynamics in the first 23 farmer groups from August 2008 to November 2010.

The factors contributing to the increased sale of young cattle in the region include a) farmers need cash to meet immediate costs associated with daily household consumption, school fees etc., b) farmers do not have space to plant forages to feed more cattle (37% farmers in this study do not have access to land) or do not have enough space to house more cattle, and c) many farmers are keepers not producers (i.e. they manage other people's cattle and must sell the cattle when the owners want to do so).

Nevertheless, there was a significant increase in overall cattle productivity. Based on the values for calving rate, calf mortality and weaning weight given in Table 1, productivity per 100 cows more than doubled from 3687kg to 7454kg.

Sustainability of the system

With limited space in existing kandangs to house new animals and little additional land to grow forages to feed them, increased productivity creates a challenge to the sustainability of the system in this resource limited environment. However, the systems are still functioning in many farmer groups.

Based on a recent post project survey conducted during August – December 2015 (Dahlanuddin et al 2015 unpublished) three farmer groups are no longer active and 33 farmer groups are still functioning. Only four out of the 36 farmer groups involved in the project continue to implement all the IVMS components with the remaining groups implement some components only. Current adoption profiles can be detailed as follows:

a. Use of selected bulls are implemented by a majority of farmers in all of the 33 active farmer groups (100% of active farmer groups). However, not all farmer

groups implement bull management as they used to do during the project life. They mostly use bulls belonging to a group member. This is because mutual agreement on the use of project bull is no longer effective.

b. Mating heifers at 18 months of age is implemented by a majority of farmers in 29 farmer groups (88% of active farmer groups)
c. Planting and use of improved forages are implemented by a majority of farmers in 28 farmer groups (85% of active farmer groups)
d. Mating cows 40-60 days after calving are implemented by a majority of farmers in 20 farmer groups (61% of active farmer groups)
e. Feeding improved feeds to late pregnant and lactating cows is implemented by a majority of farmers in 12 farmer groups (36% of active farmer groups)
f. Feeding better feeds to newly weaned calves is implemented by a majority of farmers in 9 farmer groups (27% of active farmer groups)
g. Weaning calves at 6 months is implemented by a majority of farmers in only 7 farmer groups (21% of active farmer groups)

In depth interviews with farmers representing active and less active farmer groups indicated that low post-project adoption of IVMS components was due to lack of facilitation by OGT after the project was completed. No follow on facilitation was supported by government or non government agencies. It seems that farmers prefer continuous facilitation as it is difficult for farmer groups to identify, test and adopt new practices and technology using their own resources.

Some groups voluntarily record the birth date of their calves. One of the external factors that motivate the farmer groups to continue implementing the IVMS is the premium price offered by the local government (as part of their beef cattle improvement program) for fast growing calves of known age. Some of the better performing groups have been regularly visited by scientists and farmers from other parts of Indonesia and some international visitors, as examples of good practice in herd management. Unfortunately, the cattle markets do not offer any price incentive for high quality Bali cattle such as weaned calves with high weaning weight and known birth date. Cattle are commonly priced based on height (for breeding stock) or by the trader's best estimate of carcass weight (for slaughter cattle) while qualitative traits such as weight for age, or quality of a heifer for breeding, have little influence on the price.

Ideally, the market should be a key driver for widespread and sustainability of the IVMS innovation (Triomphe and Rajalahti, 2013). However, as there is little price incentive for high quality cattle produced from a system with better feeding and management, scaling out of the IVMS is not market driven.

Sustainability of the system is also challenged by programs both from government and non government agencies that provide hand outs without encouraging farmer participation and pay little attention to improving farmer capacity to trial, adopt and adapt new practices. While well intentioned, many programs focus on increasing herd size, rather than increasing farmer benefit and create a challenge to maintain farmer participation and motivation to improve cattle productivity based on existing resources.

Conclusions

- Uptake of IVMS by farmers resulted in Bali cattle productivity in Central Lombok more than doubling regional baselines for a calf-cow system. Key productivity indicators such as calving rate, birth weight, calf mortality rate and weaning

weight improved as a result of project participation, but the improved performance of the system was observed as increased throughput, not increased herd size. In a region of limited space for housing and feed, farmers were able to convert this new efficiency into increased sales without excessive strain on existing resources.

- Uptake of IVMS was facilitated by the well trained and mentored OGT, who successfully introduced the IVMS approach to more than 1500 farmers in four years. Ongoing support and facilitation of collective actions by OGTs improved both farm productivity and the capacity of farmer groups to trial, adopt and adapt new practices.

- The practices promoted by the project were largely built on existing knowledge (eg forages and feeding, cattlemanagement) and infrastructure (eg housing) and further developing how resources can be perceived and optimized. This, along with the empowerment and social capital that communal success nurtures, has made adoption of IVMS more accessible for many households.

- Expansion of IVMS from the project groups to non-project 'satellite' groups was limited by limited access to information and subsequent uncertainty of the value of IVMS components, other than access to a quality bull being housed nearby. It seems therefore, to achieve widespread geographical benefit and impact over longer distances, that replication of key components to an increased number of farmer groups seems more viable (or faster) than farmer to farmer interactions.

- Sustainability of this system could be supported by programs that encourage better use and management of existing resources, farmer participation, communal action, provision and facilitation of information and innovation, and that support the development of market incentives for enhanced production.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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