Development of a participatory, farming systems approach to improving Bali cattle production in the smallholder crop-livestock systems of Eastern Indonesia

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Summary. Bali cattle account for about one quarter of the total cattle population in Indonesia and are particularly important in the smallholder farming enterprises of the eastern islands. Currently, demand within Indonesia for beef cattle both for meat and live cattle for resettlement areas exceeds the local capacity to supply these animals and as a consequence the population of Bali cattle is actually declining in most areas of Eastern Indonesia. A range of constraints relating to the availability and quality of forages, and animal management need to be overcome if smallholder farmers are to redress this trend and, while the approaches and technologies (e.g. improved forages, controlled mating) exist to address these constraints, adoption by farmers to date has been sporadic. This paper reports on findings from a major study with smallholder farmers in Eastern Indonesia to develop, test and apply tools and knowledge sharing techniques for evaluating strategies to improve Bali cattle production. The approach combines the principles of farming system research with strong farmer participation in all steps from system benchmarking, the identification of cattle/forage improvement options and the on-farm testing and communication of findings. The work involved a multi-disciplinary team comprised of forage, livestock, farming systems scientists, social scientists, resource economists and extension specialists drawn from a range of Indonesian and Australian Government agricultural research, development and extension agencies.

Approach

Quantify and understand the farming system

The first step involved collecting a range of socio-economic and biophysical data to develop an understanding of how the system functions and to quantify the resource flows and farm productivity. This information/data was used to develop and parameterise simulation models used later to analyse the farming system and to explore alternative management options and, as a baseline against which the performance of alternative practices can be compared and evaluated. The required social and economic information was sourced from a combination of historical village records, structured interviews with farmer groups and individual farmers, and the ‘expert-knowledge’ of staff from the collaborating research, development and extension agencies. The interviews were complemented by the collection of various primary biophysical data relating to forage availability (i.e. composition, quantity, quality), feed management (i.e. grazing, cut and carry, supplements), cattle breeding cycles (i.e. times of mating, calving and weaning), cattle performance (i.e. liveweight gain, condition score, disease, dimensions), soil characteristics (i.e. key physical and soil attributes) and climate (i.e. long and short term records of temperature, rainfall and radiation). All of this data and information was gathered into a central database with standardised formatting and quality control procedures.

Develop desktop simulation tools
A whole farm simulation model (referred to as the Integrated Analysis Tool or IAT) was developed to capture the key socio-economic and biophysical processes and their interactions within the target smallholder farming systems. The model enables the operator and farmer to rapidly assess the potential production and socio-economic impacts of changes in the system state (i.e. management, climate, soil, prices, costs). The IAT brings together three separate models: a pre-existing farming system model (APSIM) that captures the growth and yield of crops and forages under different climate/soil/management combinations; a model for simulating Bali cattle growth in response to feed quality and availability; and a smallholder enterprise economic model that simulates the flow and balances of key economic resources (i.e. land area, labour and household cash).

**Identify opportunities for Bali cattle improvement**

At the end of the initial benchmarking activities, farmer group meetings were held in each focus village. At these meetings, the benchmarking results were presented and discussed with the farmers to ensure their validity. Small group discussions were then held in which farmers were asked to identify constraints to livestock production and to nominate potential solutions to address those constraints.

There was surprising uniformity across the trial regions in terms of identified constraints which included feed availability, stock water availability, insufficient capital to increase herd size, labour constraints for collecting feed, market shortcomings, disease, inadequate knowledge of optimum feed management, access to bulls and over-long breeding cycles. Various strategies for addressing these constraints were then identified by the farmers and research team including: better utilisation of existing forages, introduction of new improved forages, development of feed plans; controlled mating and; early weaning. The IAT was subsequently used to explore the potential economic and production impacts of these strategies and to identify feasible and viable ‘best-bet’ strategies worthy of trialling on-farm.

**On-farm testing of opportunities**

Having reached agreement on strategies that were both feasible from resource supply and social perspectives, and which were shown by the model to improve the financial welfare of the household, the next step was to test them on farm. These on-farm trials provided an opportunity for farmers to experience and test the best-bet strategies, and served to demonstrate / communicate project findings and methods. So far as possible the trial sites were located in accessible, highly visible locations to facilitate extension activities. In the first year, the trials focussed on assessing a range of different grass and legume forage species. Farmers were encouraged to establish an area large enough to enable rudimentary feeding trials and to explore the impacts on cattle growth. At the end of this first year, farmers had formed a view in terms of the preferred forage species and were encouraged in the second and following seasons to expand the area of forage production and to trial other best-bet technologies such as preferential feeding, seasonal mating and feed budgeting. Farmers were periodically interviewed to evaluate their experiences and impressions. Impacts on forage availability and cattle performance were monitored regularly for 12-24 months after implementation.

**Regional extension of the best-bet technologies**
The on-farm trials served as a centrepiece for regular field days at which farmers from neighbouring villages were provided the opportunity to view the technology on offer, view performance data from the monitoring activities, and hear first hand, the views and experiences of the case study farmers. To facilitate less formal, incidental exchanges between farmers and within farmer groups, permanent signs were established at each trial site detailing the objectives and methods of each trial. All extension activities were co-ordinated and run by local government development and extension staff with all materials presented in either Bahasa Indonesia and/or the local dialect.

**Impacts to date**

Project activity was conducted at four sites in eastern Indonesia: 1) Satuan Pemukiman A (SPa) village in Sumbawa; 2) Lombo Tenggah, Pattappa and Harapan villages near Barru in South Sulawesi; 3) Mertak village in southern Lombok and; 4) Lemoa and Manyampa villages in the Parangloe subdistrict of the Gowa Regency in South Sulawesi.

A total of 142 best-bet options relating to forage and cattle management were identified for the 40 best-bet farmers (Figure 1). Of these, 85 were trialled on-farm during the period from November 2005 to February 2008. Exit interviews with farmers at the end of the project confirmed that the main forage improvement practices of establishing mixed forage banks and enhancing existing/establishing tree legumes were either successfully pursued by the majority of the households, were already being trialled to some extent, or would be in the coming season. Relatively few of the households reported having tried these particular practices and made a definite decision to abandon them in the future. Only a small number of households had undertaken any form of conservation of forages or crop residues, preferring to use the material when it was available in the field immediately after harvest, or to burn it.

![Figure 1. Application outcome for ‘best-best’ activities - all sites. (L1=lowland; L2=upland; BY=backyard; kandang=communal cattle housing overnight)](image-url)
Of the three main cattle management practices of controlled mating, early weaning and preferential feeding, more than half the households had applied the latter two practices. Most of the remaining households recognised the potential benefit of both practices and intended to employ them in the coming season or when they at least had a calf to warrant it. The timing and extent of farmer uptake of early weaning / preferential feeding is dependent on the availability of calves and (simultaneously) high quality forage. While these options were identified in the original farmer interviews and canvassed with all best-bet farmers throughout the course of the best-bet program, they were mostly tackled once forage constraints had been addressed in line with the step-wise approach described earlier. This mainly occurred in the second wet season when calves of around 6-7 months age and high quality forage were both available. Less than one quarter of the households had practiced controlled mating of their cattle, the majority of whom had achieved this independent of the project failure to do so was largely due to inability to confine cattle or difficulties in finding suitable bulls at the appropriate mating time. The highest rate of adoption of improved cattle management strategies was in SPA. With the exception of Pattappa, at least some best-bet farmers in each study village had commenced some form of controlled mating by February 2008.

All best-bet households at SPA constructed a trough for recycling grey water in the dry season and had used it successfully during the course of the project. While attribution of this uptake to the current project is somewhat confounded by the fact that at least one of the best-bet farmers was recycling grey water prior to the project commencing, the approach was actively encouraged during the workshop and through the provision of cement to some of the best-bet farmers. Cement was also provided to each of the best-bet households in Desa Mertak, but no structures had been erected at the time of the exit interviews. This was due to problems obtaining suitable local sand for concrete.

Farmers were influenced and motivated not only by the actions of the project team but also by interactions with other farmers (via field days and less formal interactions) and the legacy of previous ACIAR projects. Hence, while most farmers adopted the initial best-bet strategies, there were some deviations over the course of the project. All best-bet farmers that attended field days at one of the other established sites commented that these visits were important in terms of providing knowledge, ideas and motivation (and in many cases planting material!).

Forage production
Since the commencement of the best-bet program, many farmers have significantly expanded their original forage introduction best-bet areas. For example, Amaq Warni (SPA) plans to plant up to 1 ha of new grasses and legumes in his upland and re-locate all of his cattle operations to that site. Many farmers have also expanded plantings of pre-existing elephant grass and *Gliricidia*. For example, Sudding (Harapan) now has 1ha of elephant grass in addition to an area of new forages; Mahmud (Lombo Tenggah) has planted 600m of *Gliricidia* hedges for forage.

Cattle production
Responses from the exit interviews showed a strong level of agreement that the strategies employed during the project were already leading to improved cattle productivity.

The view that availability of forages was already having an effect on animal performance was particularly strong when considering the body condition of all classes of animals and the growth rate of young cattle. While less than one quarter of the households thought there had been an improvement in reproductive performance of their cows, almost half were sure that their cattle were now much more valuable than those of similar age and sex owned by other households in their communities, margins in the order of 33-50% being commonly suggested. Nevertheless, a significant number of households were uncertain as to whether there was any difference in animal performance or still thought it was too early to be definite - particularly with respect to calving performance and cattle prices.

Isolating the specific impact of individual best-bet activities through the on-farm monitoring activities is difficult, especially in the early stages of the new forage introductions where the contribution to total forage supply is often relatively small, and farmers often chose to save their forage banks for late dry season cut and carry use or as planting material. The difficulty is compounded by the relatively infrequent monitoring intervals. As these were mere snapshots of forage use at that time, they occasionally missed the feeding of smaller areas of new forages. Furthermore, the utility of cattle monitoring data for assessing impacts arising from individual farmer best-bet activities is often compromised by the small numbers of stock involved and relatively short turnover times for some classes of animals, especially young males, which are sold off to meet planned or unplanned household cash needs or share farmed out to other farmers. Nevertheless there were many examples where the individual or combined impacts of a farmer’s best-bet activities led to measurable improvements in both forage supply and cattle condition.

**Crop production**

Results from the exit interviews show that only 6 of the 40 best-bet households had actually decreased the area planted to food and cash crops, while another 2 households had made some direct change to the mix of cropping activities in their farming systems. Most of this small group had actually made a significant commitment to planting forages on their available land. None of the 40 households suggested that their present commitment to trialling forages and livestock had any adverse impact on the performance of their cropping activities, and a small number reported an improvement in their crop yields. The cases of increased crop areas and/or improved yields appear to have been facilitated by labour savings in cut and carry tasks resulting from more ready access to forage sources closer to their house yards.

**Labour**

Sourcing forages and water for livestock is typically a time-consuming activity for smallholder households, particularly in the dry season when forage availability becomes particularly limited. Therefore, the impact of trialling the forages and animal husbandry practices on household labour demands was of particular interest to the project.
With respect to sourcing forages from beyond the boundaries of the immediate community, the majority of households reported no change in the labour in this task. The 9 households that did experience a saving in labour used to source forages from outside their local community were all from SPA and Mertak (representing most of the best-bet households). These are particularly dry locations, for which hiring trucks to collect residues and straws from other regions several times during the dry season, was previously a common and expensive practice. In most cases, this activity and its associated financial cost had been entirely eliminated. While the project recommended using household grey water, the majority of households also reported no change in labour committed to procuring water for their livestock. The 5 households that did report a saving in labour allocated to this task were all from SPA kampung which had previously been a recipient community for GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit) sponsored rainwater tanks and in which several of the best-bet households had successfully trialled grey water recycling. The households in Mertak were keen to trial grey water recycling, but had encountered delays in procuring cement to construct troughs prior to the last dry season and, at the time of interview, also reported difficulties in locally obtaining suitable sand for making concrete. By far the largest impact on labour relates to on-farm labour use for both forage and cattle management where almost half the households reported definite labour savings, and one quarter were uncertain about the impact to date. For the former group, the actual savings in household labour were quite significant with most households reporting that previous practices had involved 1-2 family members spending 6-8 hours per day for most of the dry season (either supervising cattle grazing away from their house yards or undertaking cut and carry or cut and drop activities). Only 1-2 hours per day was now spent on feeding and managing cattle. The majority of households who felt that it was too early to determine if there was any labour saving had also only planted relatively small areas of forages. Most of this group intended to expand their forage areas in the coming seasons and anticipated similar savings.

Consistent with the previous observation that crop areas and, to a lesser extent crop yields, had increased or were unaffected by the best-bet practice changes for many of the households, most of the households reporting freed up labour had allocated that extra labour to crop management tasks. About half that number used the freed up labour to further intensify their forage and cattle management practices and the remainder used it to support either non-farm or off-farm employment activities or simply to rest.

**Household finances**

Beyond the gains revealed in labour, crop and animal productivity for many households, an important consideration is whether the forage and livestock practices being trialled by the best-bet households are actually making them financially better off.

None of the best-bet households reported having their income decrease as a direct result of trialling the forages and livestock management practices, and only 2 households were definite about there having been no change so far. The majority of households either had already experienced an increase in their income or were not yet in a position to respond positively. Basically, the bulk of the income gain, where this was recorded was the result of producing additional cattle that, to the time of
interview, had already been sold. Most of the households that were uncertain or felt it too early to report financial success either had more cattle on hand already (e.g. live calves) or had pregnant cows, but had not actually sold any more cattle yet. As many households had reported that their cattle were growing faster or were in much better condition than previously, there was a clear expectation that they would enjoy higher incomes in the future with the cattle being sold. Many of the households who recorded increased incomes were reluctant to specifically state how much additional income had been generated from the livestock sales. However, the estimates that were provided were of the order of 50%-300% gain with young animals fetching around Rp 2-3million and typically involved selling 1-2 extra animals per year.

Having determined that the practices had already brought some financial benefit, or promised such, how this additional income might have been used was also of interest. Much of the additional income from cattle sales was used to acquire or improve major capital assets, particularly house construction and motor vehicles, and to a lesser extent purchase of land and more cattle. Education and travel were also financed by several of the households, mostly to support older children (school fees) and young adults (travel to distant work sites). While several households had previously constructed small kandangs to support their livestock activities, this was not a nominated use for any additional income. Also, while accumulation and sale of cattle are a long-recognised path to finance travel associated with religious aspirations (Haj) and several of the best-bet households were headed by community-respected Haji, none of the households had as yet used their additional incomes for this particular purpose.

Beyond seeing forages and cattle as being more capable of withstanding climatic shocks than crops, having access to increased numbers of cattle and the ability to feed them year around meant that they held security against such setbacks. Moreover, owning such collateral also meant they were sufficiently creditworthy to be able to access credit if it were needed on much more favourable terms than otherwise. Many households suggested that they were more confident to face the future because, not only were they more financially secure, they also felt that having overcome the hurdle of safeguarding their financial future through a major shift in their farming systems, they could apply similar problem-solving capabilities to tackle new challenges as such emerged.

**Interest from other farmers**

Beyond a major role in trialling and refining their best-bet practices, the participating households were also seen to represent important platforms for extending the practices to other households as part of the natural technology diffusion process. The households were asked about the interest shown in what they were doing by other households in the community. The majority of best-bet households interviewed had fielded some inquiries from other households about their involvement in the project or about some particular aspect of the practices that they had been trialling. Results from the exit interviews (and from records kept by individual farmers) indicate significant interest from other farmers in best-bet activities. The number of inquiries was generally higher at the more mature sites of SPA (~130) and Barru (~120) compared to Lemoa / Manyampa (~17) and Mertak (~10).
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