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December 23, 1993

To: Terry Smutylo

Fm: C Devendra

Re: Evaluation of TSFS Project (90-0263)

Please find enclosed the report by the Evaluation Team. I believe it is a thorough analysis and generally appreciative of the excellence of the results.

With best wishes.

cc: A McNaughton

CD/dg

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# I. MEMBERS OF THE EVALUATION TEAM

## (A) Dr Charan Chantalakhana

Is Professor in Animal Science, Kasetsart University. He received the B.S in Animal Science (Iowa State University, 1959) and M.S. and Ph.D in Animal Breeding (Iowa State University, 1962 and 1968). He joined Kasetsart University in 1962. His former positions include Head of Animal Science Department and Vice President of Kasetsart University. He has received several awards for research achievement related to buffalo production and village livestock farming. He teaches various courses including research methodology and statistics. He was a former member of TAC (Technical Advisory Committee) of CGIAR and is a member of Expert Panel on Animal Genetic Resource of FAO/UN. He is also past president of the AAAP (Asian-Australasian Association of Animal Production Societies).

His present position is Director of Animal Research and Development of Kasetsart University, and President of the Animal Husbandry Association of Thailand (AHAT).

## (B) Dr Mohammad Sabrani

He graduated in 1961 from UP Los Banos in the Philippines, in Animal Science, and then joined the Research Institute for Animal Production in the same year, working as livestock production researcher. In 1972, he received the MEc from the University of New England and continued up to doctor in Agriculture/Livestock Economic at Gadjah Mada University. He became director of research Institute for Animal Production 1990-1993. He is presently coordinator of Sumba Angola research project. He is a member of technical team of Upland Agricultural; Research and Development in Central Java and Yogyakarta.

## (C) Dr Hans Anwarhan

Dr Anwarhan started his career in the Faculty of Agriculture, University of Lamburg Manghurst as a lecturer in 1968. After four years of service and transferred to Banjarbaru Research Institute for Food Crops (BARIF) and assumed a new position as research coordinator for deepwater rice, cropping systems, and problem soils from 1972-1979. In 1980, became the director of BARIF and continued until 1987. He was then assigned to the Central Research Institute for Food Crops (CRIFC) as Head of Planning Department from 1987 to 1990. During that time, he was also appointed as national coordinator for EEC-CIRAD sponsored project Soybean Yield Gap Analysis Project (SYGAP). In 1991, he was assigned to the IDRC sponsored project Crop-Animal Systems Research Project (CASRP).

(D) **Dr Cesar C Sevilla**

Is Assistant Professor, Institute of Animal Science at the University of the Philippines at Los Banos. He earned his B.S. Agriculture and M.Sc. degrees from UPLB and Ph.D degree from the University of Queensland, Australia in 1985. His present research activities include small ruminant nutrition, draught animal power and farming systems. Since 1986, he has been involved in research and development planning for ruminants as member of technical team of the Philippine Council for Agriculture and National Resources Research and Development. Concurrently, he is the project leader of the 'Crop-Animal Systems Research", an IDRC-funded project and also provides technical assistance to ARFSN, IRRI through monitoring of crop-animal projects of member countries.

## II. TERMS OF REFERENCE OF THE EVALUATION TEAM

1) Review all aspects of project formulation, monitoring and implementation, and their appropriateness over the entire duration including Phases I and II (1984 - 1993).

   Define the issues of the evaluation at the outset, set out the questions, establish appropriate indicators, modes of data collection and their use. It is important to give relative emphasis to each of these issues in order to focus specifically on development effectiveness and impact.

2) Review the results of individual objectives, results achieved, their relevance and the extent of which the objectives were realised.

   It is relevant to examine data collection from the inception, monitoring procedures of farmers in the project and outside it, in order to assess changes, differences of knowledge.

   The evaluation team should also make suggestions on how to build on this data for further use.

3) Comment on the technical merits of the project, including both weaknesses and positive aspects.

4) Comment also on the effectiveness of project leadership and team effort in pursuing the objectives and working with farmers.

It is appropriate to have separate interviews team and informal discussions with the project team in order to get inputs for the study.

5) Comment on the project's impact of the results and their importance to the development of sustainable agriculture in dryland farming areas.

6) Comment on the importance of training, communication methods and dissemination activities.

7) Identify any other relevant issues appropriate to this evaluation.

## III. PROJECT OBJECTIVES

### (A) General Objectives - Phase I

The overall objective of the Three Strata System (TSS) is to increase farmer income through improved management of the land-crop-animal system.

### (B) Specific Objectives - Phase I

The specific objective is to define a three strata production model for food and feed for the semi-arid areas of Bali by:

a) Evaluating growth and yield of grass, legume, shrub, tree and crop components of the TSS.

b) Measuring the nutritive value of the feed sources produced in the system.

c) Measuring the performance (growth, feed intake, carcass quality) of Bali cattle raised in the system.

d) Evaluating the carrying capacity of the system

e) Comparing the economic and ecological advantages of the TSS to the existing traditional system (NTS).

(C) **Communication Strategies for TSFS**

This supplemental project will provide the team with additional funds to enable it to:

a) carry out a socio-economic study in the new project sites;

b) based on the results of the above study, finalise communication/extension strategies for introducing TSFS to the sites; and

c) evaluate the results of this supplemental project.

(D) **General Objectives - Phase II**

The overall objective of the TSFS is to increase farmer's income through improved management of the land in mix crop-animal systems.

(E) **Specific Objectives - Phase II**

a) Assess the effects of the introduction of goats on the TSFS model including income generation.

b) Study the chemical composition and nutritive value of *Gliricidia* forage.

c) Study the feeding behaviour and utilisation of *Gliricidia* by goats.

d) Assess the impact of the overall interventions on the TSFS model.

## IV. PROJECT TEAM

| | | | |
|---|---|---|---|
| 1. | Professor Dr. I.M. Nitis | : | TSFS Project Leader |
| 2. | Dr. K. Lana | : | Animal Nutrition |
| 3. | Dr. M. Suarna | : | Agronomy |
| 4. | Dr. W. Arga | : | Agriculture-economy |
| 5. | Ir. S. Putra | : | Forage |
| 6. | Ir. W. Sukanten | : | Nutritive value |
| 7. | Ir. I.N.G. Ustriyana | : | Socio-economy |
| 8. | Dra. Luh Arjani | : | Anthropology |
| 9. | Drh. W. Bebas | : | Cattle Health |

10. Drh. N. Suata : Goat health

## V. BACKGROUND

Bali is an island of 5,620 $km^2$ with 3 million people. The topography is undulating with a chain of hills in the centre and flat region in the south and north. There are wet, semi-arid and arid regions determined by the 900-3,000 mm annual monsoonal rainfall. 20-25% of the total island area receives 900-1,500 mm annually. The soil is generally of regosol, latosol and mediteran types. 60-70% of the population are farmers, and most practise mixed farming with cattle. The agriculture produce rice, beans and corn are mainly for home consumption, whereas cattle, pig, coffee and coconut are export earning commodity. There are 380,000 head of cattle in Bali with an export quota of 25,000 head/year.

The net income is CAD$120 per capita. In the wet region, the income from livestock is 10% of the net farm income, whereas in the semi-arid and arid regions the livestock income is 29 and 43% of the net farm income, respectively.

Farmers constitute about 70% of the total population, and most of them practice mixed crop-animal farming. Among ruminants, Bali cattle are particularly important and in the dry parts of the island, income from livestock account for about 29-43% of total farm income. Farmers generally own 2-3 heads of cattle which are used for draught and beef production.

Bali has about 560 "desa" (village) there is administrative head and cultural head; the latter plays an important role in the daily social and economic life of the Balinese. With its "Banjur" system (Banjar is the smallest unit of the desa), rules and regulations are made to ensure peace, security, freedom and interdependent activities in the village. The spirit of "gotong royong" (communal work) becomes the base of the economic life of the Balinese people.

The feed resources for ruminants in Bali come mainly from native grasses, tree leaves and cereal straws. The dry matter productivity from these resources is generally very low (approximately 2-2.5 tons/ha/yr). Dry matter yields can be increased through the introduction of improved grasses as well as forage legumes, eg. leucaena (*Leucaena leucocephala*) and *Gliricidia sepium*.

In Indonesia there are 3 kinds of beef cattle traditionally raised:

Ongole cattle found in Java, Madura cattle in Madura and Bali cattle in Bali. The Indonesian Government is now spreading these cattle into the following regions in Indonesia:

a) Ongole cattle: Java, Sumatra, Sumbawa, Kalimantan and West Irian

b) Madura cattle: Confined to Madura only

c) Bali cattle: Bali, Lombok, Flores, Sumba, Timor, Sulawesi and West Irian.

Cross breeding is not allowed for the Madura cattle in Madura and Bali cattle in Bali, whereas in the other islands such undertaking is permissible.

Bali cattle have the highest carcass dressing percentage of the three. Efficiency of feed utilization and calving crop of Bali cattle is also higher. In Bali the cattle are used mainly for draft. When reaching 375 kg live weight it can be sold as export animal to Jakarta or Hongkong.

The middle of Bali has been destined for beef production under intensive management, there are also some areas with 900-1,500 mm annual rainfall which have potential for semi-intensive beef cattle production. Such areas are located in east of Bali (Kubu area), south of Bali (Bukit Peninsula area), north west of Bali (Sendang and Sumberbatok area) and offshore island of Nusa Penida. These are the target areas for this research project.

Cattle generally feed on wayside grasses and crop residues. Live weight gains obtained vary between 100-200 g/day. Therefore, approximately 4-5 years are required to reach marketable weights. With improved feeding as well as concentrate supplementation, in a previous IDRC-supported project (77-0087), it was shown that daily weight gains of Bali cattle could be increased to between 400-600 g/day, and also that the fattening period could be reduced to less than two years.

Through the Provincial Department of Animal Husbandry priority has been to the Bali cattle development. The farmers are encouraged to raise cattle for manure production and meat production without concentrates. Research financed by the provincial government and IDRC carried out by Udayana University on the aspect of breeding, management, disease control, economics, nutrition and extension on Bali cattle have been carried out since 1970.

A major constraint to higher productivity from ruminants is the unavailability of good quality feeds especially during the dry season. Feeding systems can be developed to increase the supply of good quality forages, and therefore dietary nutrients for the animals. This will greatly improve the prevailing low level of performance.

Previous research has shown annual roughage production of 3.8 million tonnes (dry matter). 79% is found in the dryland farming areas consisting of native grasses, tree leaves, shrub leaves and crop residues.

The native grass and legume production varied from 2.6 in wet farming area to 3.2 (DM tonnes/ha/yr) in the dryland farming area. The introduced grass such as Panicum maximum produces 6.7 to 8.9 and Cenchrus ciliaris 6.5 to 8.4. The introduced legume Stylosanthes guyanensis could produce 6-10 and the introduced Macroptilium antropurpureum could produce 6-14 (DM tonnes/ha/yr). (See Nitis et al, 1980; Nitis, 1984; Nitis et al, 1985).

## VI. EVALUATION FINDINGS

### PROJECT CONCEPT

### (A) Formulation

The general objective of the project is to increase farm's income through improved management of land-crop-animal system.

This objective reflects the national as well as the regional goal where environment, soil fertility, human resources and welfare are included. In Indonesia, three major tropical breeds of cattle are raised by farmers, the Madura, Ongole and Bali. In addition to that goats are also numerically very important. Bali cattle are well distributed in Bali, Lombok, Sumbawa, Flores, Timor, Sulawesi and Irian Jaya. This policy is designed to develop those islands become sources of pure Bali cattle. In connection with cattle development, the improvements of forage supply and quality are taking place. Nine forage seed centres were established which provide improved seeds and cuttings of grasses, legumes, shrubs, and tree legumes for animal feeds.

The major undertaking of the project is the establishment of the three strata of forage system as well as improve animal production. The main fields of research include forage, crops, agronomy, animal nutrition and socio-economics. The program was to include studies on trees, shrub lugumes, grasses, soils, Bali cattle, goats and also the utilisation of animal manure.

The evaluation team (henceforth referred to as 'The Team') considers that the animal species chosen for study are relevant, however, provisions could have also be made to do research on village chicken and pigs. The component of animal health research should be specified clearly because diseases might be one of source of farming risk.

A distinctive feature of the present livestock industry is the production of the major proportion of output from small farms rather than from commercial livestock operations. Account must be taken in the project formulation, that the beneficiaries are small farmers. In these circumstances, the study on small farmers behaviour should be included in research strategies. Therefore research should be designed to provide opportunities for the farmers to adopt the TSFS technology packages and to achieve the optimum use of their resources, rather than only to maximize the production in mixed farming systems.

## (B) Methodologies

### (i) The TSFS Technology

The three strata forage system (TSFS) is a system of planting and harvesting grasses, legumes, shrubs and fodder trees, on the same plot of land so that the supply of forage for animal feeding becomes available all year round, while food crop production remains as the most important component of the existing farming systems.

It was evident that farmers in dryland, semi-arid, farming areas of Bali Island have traditionally grown trees around various locations of the farm, for instance along the fence line, terrace walls, or around the households. The use of tree leaves for ruminant feeding has generally been practised by farmers in these areas both during the wet and dry seasons. However, during the dry season, when ruminant feeds from grasses or legume forages became critically scarce, the use of tree leaves for ruminant feeding significantly increased (25% in the wet season vs 39% in the dry season). In addition, cattle raising in these areas was very common. Almost every household kept 1 to 3 Bali cattle, in some extreme cases the number was as high as 15 cattle. The traditional requirement for fencing and windbreak also appeared to be supportive to the TSFS methodologies. Farmer's traditional cultural practices, for example tillage of crop field using a pair of draught cattle to pull the plow tended to leave a small strip of land along the edge or periphery of the field for grass growing.

The use of TSFS technology appeared to be most suitable in the semi-arid areas (900-1500 mm rainfall) where soil fertility is poor and soil erosion os a major problem. The use of TSFS could increase soil organic matter and reduce soil erosion. Growing legume species of forage and shrub could increase soil nitrogen.

The Government of Indonesia has promoted Bali cattle raising and the major cattle production area was mainly located in the dryland areas of Bali. Feed supply for cattle raising during the dry season therefore became more critical, while many farmers, for instance those in Bukit Peninsula area, had to purchase grasses from Denpasar to feed cattle or goats during the late dry season (25,000 Rup/lorry load). The TSFS methodologies offer a good opportunity for enhancing the current government of Indonesia campaign for tree planting.

However, the TSFS methodologies may not be economically acceptable in the high rainfall (>1500mm) areas, especially where soil fertility is good, since farmers are inclined to grow cash or food crops instead of forages in such areas. In high rainfall areas such as lowland paddy areas in Bali, farmers can obtain forages for cattle all the year round both from within and outside the farm.

The average size of landholdings in Bali could also play an important part for the justification of the TSFS methodologies. Since the average size of landholding of around 0.2-0.3 ha, farmers have to use most of their land area for food crop production. For farmers who have a larger area of land, the TSFS methodologies can be more suitable.

The TSFS model appeared to be constrained by the fact that it involved various species of grasses, legumes, shrubs and trees, while seeds or planting materials were not always readily available at the same time. Varieties of pests or disease problems which infect different kinds of forages could upset the TSFS package technology. The specified plot size, shape, and plant spacing, as well as plants strata arrangement, though flexible as it may be, is a complicated specification, and was not simple for exterior or development personnel.

In short, the TSFS methodologies appeared to be supported by technical and biological aspects and by some socio-economic and policy factors. However, there were various constraints and adjustment which needed to be recorded and overcome.

(ii) Farmer Participation

The TSFS research involved the establishment of the TSFS unit on farmers' field. During Phase I twelve farmers were selected who must be willing to rent 0.25 to 1 ha of their land for the project, to be used for the establishment of the TSFS experimental plots. The rest of the farm area was not involved in the project. Hence, farm records outside the experimental plots were not systematically kept. The interaction between the experimental plots as a sub-system on the farm, and other sub-systems in the non-experimental farm plots could not be observed or quantify.

In order to measure the benefits of the TSFS technology, a group of 14 farmers were included in this project. They were informed about the TSFS but no TSFS experimental plots were established on their farm. This group of farmers were referred to as the non-TSFS or NTFS farmers. Some of these farmers at a later stage used Gliricidia or Leucaena to replace Cactus along the fence line. Some improved grass specica used by the project was also grown in certain spots of the farm area by some of the NTFS farmers.

In addition, seven traditional farmers (TRDS) were included in this project. These farmers raised their cattle in the traditional way, i.e. grazing or tethering around the farm and supplementing with crop-residues or straws. The TSFS and NTFS farmers kept their allotted cattle in a $4x4m^2$ stall fenced with shrubs and trees. All participating farmers were provided with cattle of more or less of uniform body size, in addition to farmer's own cattle but outside the project. The cattle provided by the project were purchased from outside the project area.

It was quite clear that the participating farmers were drawn into the project only to cooperate in the experimental trial unit, while other farm activities outside the project were not directly related to the project. However, the benefits of this project would indirectly reflect on other non-project activities of the same farm, as well as on other off-farm activities of the farmer. For instance, more time is available to seek off-farm income.

It was not possible for the TSFS project to systematically record information from other farm activities outside the project, like fruit trees and orchards, all animal activities, purchase of grasses or water, etc. Therefore, various interactions between the project component and the non-project components could not be measured.

It should also be noted that those farmers who participated in the project may not be psychologically and economically completely involved since the project dealt only with a small part of their total farm land. In other words, the economic dependency of the project farmers on the project inputs could be only partial. Hence the interpretation of some project results may not fully reflect the real effect of the project components.

During Phase II of the project the number of project farmers increased to 64, consisting of 16 TSFS farmers with cattle and/or goats, 16 TSFS farmers with cattle only, 16 NTFS with cattle only, and 16 traditional cattle farmers. The management of cattle and goats for the TSFS and NTFS groups were intensively stall fed, while the traditional farmers used the tethering method only.

The significant changes in methodology during the second phase was the integration of goats into existing cattle raising in the TSFS farms. The role of women involved in cattle and goat raising was also studied in order to observe as well as have access and control of farm resources by women, and to identify significant constraints and ways to alleviate the problems.

**TSFS UNIT IN RELATION TO WHOLE FARM SYSTEM**

BRICK

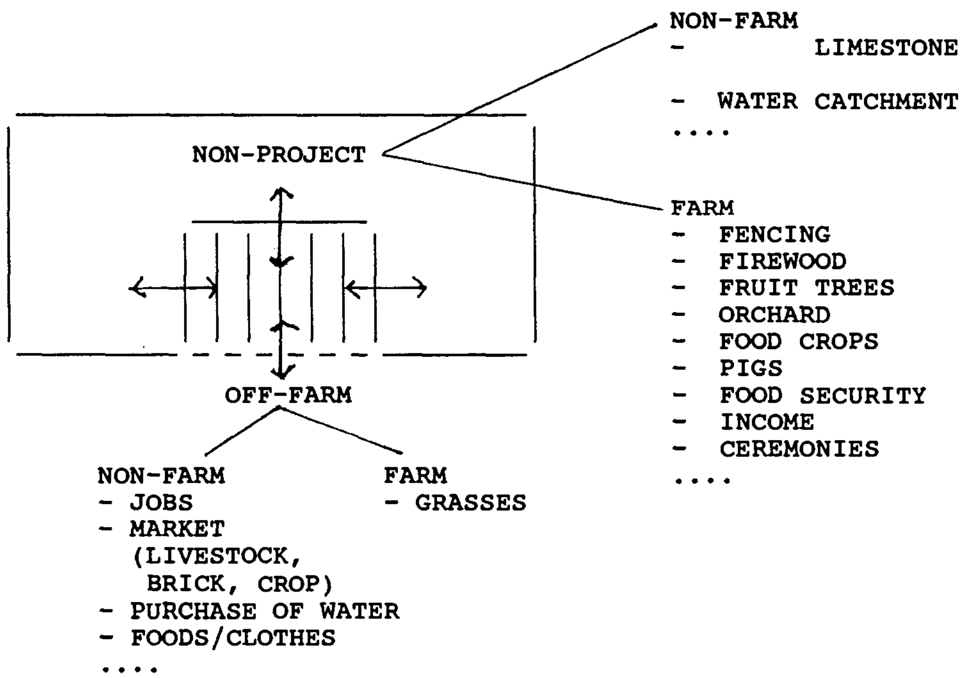

**TABLE 1. NUMBER OF FARMERS PARTICIPATING IN THE TSFS PROJECT**

| Phase I | | Phase II |
|---|---|---|
| TSFS | 12 | 16 with cattle + goats<br>16 with cattle only |
| NTFS | 14 | 16 with cattle only |
| Traditional | 7 | 16 with cattle only |
| TOTAL | 33 | 64 |

(iii) <u>The TSFS Research Approach</u>

The TSFS Research Project appeared in physical form as an on-farm research and extension in farming system research (FSR). However, it may not be totally appropriate to assess the project only in the context of FSR. It is appropriate to analyze the project with two research perspectives:

a) As an interdisciplinary (component) research being conducted on farmer's fields, instead of on research station, especially during Phase I.

b) As an on-farm research and extension efforts by a multi-disciplinary research team.

## VII. ASSESSMENT OF THE RESEARCH PROJECT

### (A) Introductory Comments

Although the TSFS research project was conducted on the farmer's field, the TSFS can be looked at as an interdisciplinary (multi-component) research project which was carried out in farmer's fields instead of the research station. This observation is reflected by the various animal feeding trials, forage varietal trials, or food crop experiments. It was also supported by the fact that the interactions between project components (animals, forages, shrubs, trees, food crops in TSFS, etc.) and non-project sub-systems, both on-farm and off-farm, could not be recorded or measured.

(B) **Component Research**

**Crops**

(i) Objectives

The objectives of Phase I were to study the effect of season and topography on the yield of food crops (corn, soybean, cassava) and forage crops (grass, shrubs and trees). In addition, water use efficiency is also studied. For Phase II, the objective was to study effect of goat and cattle manures on the yield and biomass production of food crops (corn, soybean, and cassava). These objectives have been met in accordance with the requirements for TSFS project.

(ii) Methodology

In Phase I, a factorial experiment with 2 factors (each has 2 level) were used with Raudomined block design. For Phase II, a completely Raudomined block design was used consisting of 4 fertilizer treatments and 6 replications. Through our evaluation, the interaction between the two factors are missing which makes conclusions difficult. The interpretation of data analysis in Phase II is still weak, due possibly to the misinterpretation of the data.

(iii) Key research Highlights

a) The total productivity of TSFS system is much higher (3.9 tonnes DM/unit/year) than non-three strata system (3.1 tones DM/unit/year). The increase of production in TSFS is 37% for gross, more than 100% for ground legumes, 120% for shrub legumes, and 122% for fodder trees, and 462% for firewood.

b) Verano stylo is found to grow well under semi-arid condition of Bali and yields best (63 kg DM/unit/year) as compared to some other stylo (30-35 kg DM/unit/year).

c) All fodder crops grows quite well through the TSFS management systems.

(iv) Specific Recommendations

a) The use of animal manure should be increased to improve crop yield

b) Appropriate statistical design and sampling techniques in crop research are crucial to arrive at meaningful conclusion.

c) The conflicting resource use in land for crop and grasses should be thoroughly understood before extension is started.

d) Cropping patterns should be further developed in accordance to the soil fertility conditions.

In line with the Government policy to increase food crop production, TSFS has shown its capability to help small farmers in the improvement of their food crops. In addition, the TSFS also helps to improve soil fertility, reduce soil erosion, improve soil structure, increase animal production, and conserve the environment.

It is recommended that the TSFS system should be spread to some other island of similar agro-ecosystems.

## (C) Animals

### (i) Phase I Objectives

The project objectives in Phase I on the nutritive value of feed resources and production performance of Bali cattle under TSFS were adequately met. In objective 1), the studies conducted were chemical composition, nutritive value and conservation. However, sub-studies under nutritive value on allelophate effects of Gliricidia should be under agronomy, while those on astringent odour and presence of compounds in feed source should fall under chemical composition rather than productive performance of cattle.

In objective 2), only one study was conducted consisting of eight sub-studies, of which disease and injury should be omitted and instead used as information under sub-study on cattle performance. All the objectives were met.

### (ii) Methodology

The specific methodologies for each study were adequate to achieve the corresponding objectives, except for some studies where the statistical design used was inappropriate.

### (iii) Results

Studies on the chemical composition and IVDMD of different feeds within TSFS generated valuable data as influenced by season, topography and presence of companion plant species. However, the interpretation of the results was limited to a certain extent only to that of the main factors rather than including also the interaction effects. Hence, additional information were missed.

The studies on Bali cattle performance in TSFS clearly established the feed availability and utilization in both dry and wet season. It is to be noted, however, that a two-month feed deficit persists during the long dry season. The average feed intake over the three-year period, based on the actual initial and final weights, was 4.5 kg DM/day or 2.0% of LW. This is below the expected intake of 3.0% of LW and may partly explain the low LW gain (0.18 kg) of cattle. Correspondingly, feed conversion efficiency (FCE) of Bali cattle was 28 kg/kg. These values represent one plot of TSFS.

The results of the fattening study provided three important information. First, on a year-round basis with adequate feed coming from four plots of TSFS, the optimum growth rate of cattle was 0.25 kg/day. Secondly, the FCE was 23 for TSFS and 32 kg/kg for NTFS, respectively, indicating higher feed quality from TSFS. Thirdly, the data shown that the carrying capacity of one unit of TSFS was 0.25 animal unit. This is supported by the study on feed supply and demand. Hence, stocking of one cattle/plot of TSFS may be overestimated, as a consequence of which two-month feed deficit occurs during the dry season.

The results of the study on feeding behaviour and preference of Gliricidia by cattle provided valuable data on feeding patterns of Bali cattle both in confinement and tethering. Also, on a sole Gliricidia diet, the average feed intake of Bali cattle was 2.0% of LW.

Another statistical interpretation of the same live weight data from the three-year experiment was presented under socio-economic, wherein the effect of the slope was included as a factor in addition to the forage system and stocking rate. This led to conflicting results on the effect of stocking rate on ADG from the previous study, where topography was not considered as a factor.

(iv) Phase II Objectives

In Phase II, there were two objectives related to animal component, namely, Improvement of TSFS model with the integration of goats and enhancing the utilization of Gliricidia. These were satisfactorily achieved with the conduct of 4 short-term and 3 long-term feeding trials and 2 studies on nutritive value. However, the objective on the possibility of MCF infection of cattle by goats should be dropped.

(v) Methodology

The methodologies used were adequate in most studies. Two limiting factors were the low number of replications and design of experiment, as exemplified by the study on goats fed grass, shrubs and trees and the performance of goats fed various provenances of Gliricidia, respectively.

(vi) Results

The results of studies on chemical composition and nutritive value of Gliricidia and on feeding management provided useful information in the value of Gliricidia as a supplement or sole diet for goats.

The study on the performance of goats fed various provenances of Gliricidia was constrained by the statistical design, due to a large number of treatments. Alternatively, promising provenances based on agronomic and nutritive characteristics should have been screened and then tested for palatability and voluntary intake by goats.

The partitioning of the differences in liveweight gain into body parts and carcass components might be misleading, since of all attributes considered only the weight of the skin was significantly affected by the treatment.

The other way of computing the equivalent number of goats per cattle is the use of feed requirement. Based on previous results, cattle consumed 2.0% LW and goat at 3.5% of LW. Considering the initial LW of cattle and goats at 88 and 16 kg, respectively, this one cattle is equivalent to 3 goats under the TSFS model. This estimate is supported by the findings on the effect of population size on goat performance. Consequently, this would more likely explain the better LWG in 1 cattle + 3 goats group. The disturbance in ranking order may have been due to competition for feed in high goat population density treatments.

Interpretation of the data is confounded by pooling the LW and feed intake of two species. Also, since the initial weights were found to be significantly different, the data could have been adjusted to the initial weight by convenience.

(D) **Research Highlights**

a) Established nutritive values of important trees, shrubs and grasses for dry land farming as influenced by season, topography and companion plant species.

b) Established production parameters for Bali cattle and goats under dryland conditions.

(E) **Relevance of the Results**

Since data were gathered from on-farm research, these can be used as basis for formulation of similar projects in semi-arid regions of Asia.

(F) **Specific suggestions and recommendations**

a) There is a need to explain the low dry matter intake (DMI) of cattle under TSFS.

b) More research is required on the proper combination of trees and shrubs. Multi-species forage production system is necessary as a hedge against disease/pest outbreak, as in Leucaena.

c) With all the data gathered, computer simulation and modelling should be conducted to improve the success rate of TSFS application in similar ecology but different needs and capability.

d) There may be a need to relax the rigid requirements of TSFS. This can determine using compujter simulation.

e) The carrying capacity for TSFS should be based on the dry season productions of the forages and the excess forage during wet season can be used as green manure.

f) The TSFS should be tested with other cattle and goat production systems, eg cow-calf, kid production under dryland conditions.

(G) **Socio Economic Studies**

(i) Objectives

The objectives of the socio-economic research component of the project are:

a) to compare the economic and ecological advantages of the TSFS to the existing tradition system (NTFS)

b) to determine the farmer's income

c) to assess the impact of the overall intervention of the TSFS

The methodology used to achieve objective a) is a descriptive technique. To achieve objective b) partial budget analysis was used to compare different model of TSFS as a component of farming system. The analysis was based on Grass Margin produced by each model. The objective c) was achieved by means of whole farm budget analysis of one year data to compare TSFS farmers of different activities, non TSFS farmers and demoplot farmers in North Bali.

The Team found less integration at the research planning stage among the scientists involved. This makes the socio-economic studies produced less impact-oriented, due to the extreme environment (dry and wet) soil conditions, rainfall conditions, land size, and labour availability which affects the stability of the forage, animal and crop systems. The validity of the survey at the point in time to evaluate impact is highly questionable because it does not capture the changes over time, and effects, the length of farmer's response and interactions. Therefore only an analysis of the benefits or short term impact is possible.

The results of the socio-economic analysis (Objective 2) as well as biological result showed that Model B (2 cattle and 3 goats) produced the highest performance. The limitation of this result is that cattle and goats are all males, therefore the interaction is short run in meat production (fattening), not in breeding and fattening which is a long run process. Hence the conclusion should be based on the production circumstances (fattening). The results could be different if the interaction involved breeding which will take a longer period of time. However, a technology packaging-products through model testing, require intensive research activity, continuity and longer period.

When gross margin analysis is used, the terminology should be well defined. The component of fixed cost and variable costs should also be well defined. The project gross margin, farm gross margin and farmer's gross margin should be clearly defined. The on-farm, off-farm and non-farm sources of receipts must be classified. For the analysis of the current benefits, no projected data will be used.

Training to meet small farmer needs seemlands to have enormous problem. Motivations for raising animal and establishment of TSFS as well as the constrained conditions leave little room for improvements. However, the research and demostration plots (DP) sites of TSFS and other TSFS development areas, support the appropriateness of training. At those sites, bring scientists face to face with farmers and becomes the most important mechanism to attune farmers needs. The DP and development areas should be more encouraged, regularized and brought into the farming systems.

In terms of adoption, factors affecting the success or the failure should be analysed critically. Low and high acceptance should be compared and conclusion drawn on the causal factors. A study on communication already identified low-use high adoption farmers, but there was less attempt to identify causal factors and types of interventions required.

(H) **Relevance of the Results**

This project arose from the earlier research projects which were conducted partially. No model had been developed and tested. It became apparent that the scope for increasing farmer's income should be approached through farming systems. The Team wishes to draw attention that the TSFS and animal system should be more clearly defined with more flexibility. If that is so, the system has a strong developmental implication in transmigration areas and dry, marginal areas of cattle production such as Sumbawa, Sumba, Flores and Timor islands. Tradition, general animal husbandry practices, climatic condition and market should be well integrated into the model.

(I) **Role of Women**

(i) Objectives

Since 1978, the Government of Indonesia has included programs to increase and develop the role of women in various national development programs. In agriculture almost 37% of the labour force was women.

This study was aimed at examining the role of TSFS women farmers who kept cattle and/or goats, their access and control of farm resources, as well as problems and constraints.

(ii) Methodology

A survey using questionnaire for interview was carried out during the period of seven days. Ten (10) out of 16 TSFS farmers with cattle and/or goats were women, eight of whom were married and two were single.

(iii) Results

The results from this study indicated a high illiteracy rate (30%) among women farmers. 90% of them never had any farm training on animal raising. They received their information only through their husbands or from the TSFS project. Their perception of cattle and goat raising was in general positive. In line with traditional practice, men controlled larger income and spending (cattle sale) while woman smaller income and daily spending (goat sale). No significant constraints or problems sere identified by this study, most probably due to the nature of survey method conducted in a relatively very short duration. Farm monitoring and further case studies could provide more in-depth information. Household recording if possible would also provide very good opportunity to analyze access and control of resources by women. These methods, however, would require much more time and inputs from the researchers and the project.

In this study, however, it was observed that women had less opportunity to attend training course or to obtain technical information, while men generally would attend training courses offered and then transfer their knowledge to women. Therefore, it may be desirable to find ways and means to ensure an opportunity for women to participate in any training course which might be offered in the future.

The following coments relate to the socio-economic work:

a) Pulling together the existing knowledge on TSFS and animal production in dry and marginal soil conditions, knowledge on the differential market of goats, cost structure and source of income. The economic conclusions were to drive the animal and TSFS management practices of integrating animal into the market.

b) Providing feedback to farmers in terms of TSFS and animal production practices, is an interactive process. The DP and development areas are networks amd have great potential for the future.

c) There appeared to be no socio-cultural constraints on the role of women and women's acceptance of TSFS and cattle and goat keeping on farm.

## (J) TSFS and the Farming Systems Approach

The TSFS unit can be analyzed as a package of technologies being tested on-farm in order to assess its viability, suitability, adoption by farmer, as well as its sustainability. In this context, the TSFS research can be assessed against the background of whole-farm systems, while TSFS unit can be considered as one of the many other farm sub-systems and other non-farm components such as off-farm jobs which may be related to project interventions.

In order to be able to study the relationships between the experimental components, i.e. the TSFS unit, and any possible interactions with non-project components it is necessary to keep household records of all farm and non-farm activities of each farm. With available project resources, teaching responsibilities of project staff, relatively long distance between Udayana University and the project site in Bukit Peninsula, and a limited number of field workers it was clearly not possible for the project to be able to regularly collect household records in detail and in a systematic way. Therefore, the interpretation of results, for example the economic benefits of the TSFS through animal raising, may not reflect complete on-farm situations, since household data on non-project farm activities, such as fruit tree planting, orchard, other animal raising, etc, as well as data on related non-farm activities, such as limestone brick cutting, water purchase, etc., were not available for whole-farm analysis on the benefits derived from the utilization of the TSFS technology.

If the TSFS was to be viewed (regarded) as a farming systems research, i.e. the whole farm is taken as a unit of study, the degree of farmer participation in the TSFS project at Bukit site need to be closely considered since the TSFS unit is only a small part of the whole farm. In such cases, some project farmers, who might be more interested in other non-project activities, the interpretation on the benefits of the TSFS might not truly reflect the real value that would be realized when such farmer integrated TSFS technology into his whole-farm system.

Although the participation of the farmers in the TSFS project in the Bukit site was observed to be relatively more active than those around the demonstration plot areas in Singarajak.

While the TSFS project appeared to be almost like a farming systems research project dealing with an on-farm research and extension activities, its deficiencies in certain respects as mentioned before make it look very much like an incomplete farming systems research project and in addition to these, many members of the research team appeared to be more oriented toward a disciplinary component research approach, as evident by the feeding trials in Phase II of the project. Further training in system research methodologies for most of the research staff will be very necessary in order to be able to carry out research with farming systems perspectives.

It was apparent that due to these various deficiencies, it was not possible for the project to effectively measure various interactions, say between the crop and animal components, except only in one study dealing with the use of animal as fertilizer in food crop fields.

## (K) <u>The TSFS Technology and Sustainable Agriculture</u>

The TSFS technology was also assessed in terms of its support for the concept of sustainable agriculture which involves the successful management of resources for agricultural production in order to satisfy changing needs of human while maintaining or enhancing the environment and conserving natural resources.

From a biological point of view, the TSFS is a complementary system of planting and harvesting ruminant feeds for year round feeding, especially during the dry season when animal feeds became very scarce. Some tree leaves or branches may be cut or destroyed due to the pressure of scarcity of ruminant feed supply. With the use of TSFS, this problem could be alleviated. While the TSFS provided more feed supply for animals, the use of animal manure in food crop or fruit tree production would be enhanced by the fact that it is easier for farmers to collect manure in sufficient amount since farmers tended to keep animals more at one site on in the pen, instead in grazing or in tethering.

The interactions between crops and livestock, for example through more and better utilization of crop wastes and residues or use of animal for draught power will become more and more beneficial to whole farm outputs.

The TSFS is especially suitable for the areas where soil fertility is low. With the use of TSFS in the long term it was evident that soil organic matter, soil nitrogen as well as other minerals tend to increase and improve. Trees in the TSFS also provide shade and windbreaks for animals and humans, while flowers from shrubs and trees provided a good opportunity of honey bee keeping. Birds and other useful insects are also expected to become more numerous with the existence of more trees and shrubs. With grasses and legumes as forages, other animals, such as chickens, also benefit from feeding on available seeds, insects, white ant.

In the Bukit area where fencing was traditional and required by farmers, tree and shrubs appeared to be very well accepted to replace existing <u>Cactus</u> for fencing. The TSFS along the fence line not only provides family security from intruders or outside animals, but also supplies firewood for household daily needs. Farmers would not have to look for firewood from nearby forests when they had enough firewood supply from Gliricidia and other trees in the TSFS plots or around fence line.

This study also indicated that the TSFS obtained more income from keeping ruminants such as cattle and/or goats, while farmers also had more time to seek off-farm jobs since they tended to spend less time looking for ruminant feed supply during the dry period of about 8 months. With cattle and goat keeping the role of women and children, as well as older members of the family became more productive and significant toward increasing family income.

Concerning ecological and environmental aspects, the use of TSFS in farming systems evidently reduced soil erosion to a half in the slopes at the research site in Bukit. The presence of trees and legume shrubs on terrace walls also increased soil fertility such as organic matter, nitrogen and other soil minerals. The slope area is generally lower in soil fertility. The use of legume shrubs appeared to be quite appropriate and beneficial. With the presence of more trees and shrubs, birds, insects or other animals would become more prevalent in a long term.

The use of TSFS complies with the policies of the Government of Indonesia to increase tree planting by 1 million trees per province in order to promote better environment and the quality of life of Indonesian people, especially rural farmers.

In spite of all those positive views within sustainable agriculture perspectives, the development of TSFS, like other agricultural development, will not be without problems and difficulties such as those already mentioned in previous sections. The success of TSFS will depend greatly on government policy and adoption of technology by government/NGO development agencies and officials. It is also important to provide technical inputs such as TSFS information, training, seeds and tree stocks, etc. The TSFS unit has to become more flexible in terms of size, shape, plant and tree arrangement, etc.

In conclusion, however, the TSFS is seen as an appropriate technology for sustainable agriculture especially in the dryland (semi-arid) areas and in difficult terrains such as slope land areas.

## VII. SUGGESTIONS AND RECOMMENDATIONS

a) The Team welcomed the decision that the TSFS should be integrated into the farming system

b) The team recommends that future development, the physical form of the TSFS should be replaced accordingly with soil conditions, land size, topography and farmer's needs. The model should recognize the socio-economic constraints confronting the smallholders.

c) The development of DP and TSFS application should follow a "bottom-up" approach rather than strong "top-down" approach.

d) NGO's should play an important role in combining the "top-down" and "bottom-up" approaches and backed up by incentives system.

e) In the implementation, steps should be taken to communicate with officials, selection of farmers, group formation, etc should be carried out with a high degree of accuracy and selectivity. Traditions, religions and farmer's needs should be of priority.

f) The socio-economic analysis should take into account resource allocation, gross margin, food expenditure and education based on real data. Data from TSFS plots should be analyzed initially then moved to whole term analysis.

g) It is suggested that in order to obtain more in-depth information about the issues concerning the role of women in agriculture, farm monitoring and further case studies should be conducted, while household records data would also provide more opportunity to analyze into access and control of resources by women.

## VIII. COMMENTS ON PROJECT LEADERSHIP

### (A) Project Leader

Prof. Dr. I M Nitis is highly qualified for the leadership of the TSFS project, since his education related to rural science and animal nutrition. His long years of research and teaching experiences places him in right perspectives to lead the TSFS team.

His research achievements in his field has been widely accepted both nationally and internationally. He has gained respect from his contemporaries. The results of his numerous research papers have been widely published in both national and international publications.

He was completely dedicated to his work in order to uplift the standard of living of small farmers under difficult conditions. He was a very hardworking person with very high sense of responsibility. There was not any doubt about his intention and trying to get the work done. And above all, he was a very nice person to work with. With his good human relationship, he could get along very well with people from all levels of work, ranging from poor farmers in villages to high ranking government officers such as Governor of Bali and Chief of Livestock Service. It was clear that the project had been carried out in a very efficient and effective way.

### (B) The Project Team

The project had a highly qualified team of animal nutritionists and chemical analysts of animal feeds, but training in farming systems research approach for some of these personnel would be beneficial to the project. In certain areas of research such as in socio-economics, the research team need to be strengthened by further training of individual scientists, as well as by consultation and communication with outside expertise in his or her own field in order to arrive at the best methodology to be employed in a particular study. The involvement of certain researchers, for example for the study on role of women, was only recently and through a short duration of survey. More involvement of researchers in this field with the project is needed in order to be able to arrive at more in-depth analysis of problems and constraints.

## IX. TRAINING, COMMUNICATION METHODS AND DISSEMINATION

### (A) Objectives

The objectives of the training are:

a) to improve staff capacity to do research planning, implementation and monitoring

b) to improve the knowledge of farmers about TSFS

c) to increase the rate of technology of TSFS transfer and adoption

The achievement so far was 44 staff degree training, 31 staff non-degree training, 40 TSFS farmers and 298 participants for hamlet course.

The Team considers that training is a matter requiring priority and attention. In view of the critical importance of this subject to the project it should be designed to ensure appropriateness of the curriculum and continuity. The site managers should be given more attention for their training and up-grading. The absence of site manager of this project produced low rate of adoption and expansion. One of the successful effort of NGO project is the presence of site manager who coordinates the implementation, control and correction to achieve a certain target.

In the communication aspect of TSFS, three objectives were designed:

a) to study farmer's knowledge and attitude

b) to study the impact of communication support

c) to study the pattern of TSFS personnel communication

(B) **Results**

The results showed that the majority of farmers agreed with TSFS. Variations however can be observed across locations. It seems the degree of acceptance is related to the level of activity of village leader, farmer's group leader and extension staff. To support the communication, 26 meetings were conducted, and 15 scientific papers, 2 booklets, and 5 reports on TSFS and animal production were published. The Team proposes that face to face communication between researchers and farmers is the most effective method. This can be followed by farm visits to farmers having difficulties. Also, the farmer to farmer communication should be encouraged and organized to increase the direct involvement in TSFS development. In terms of dissemination of information, the use of brochure and hamlet meeting are the most effective methods.

(C) **Extension to other areas**

Wider application of TSFS can take place in regions having close similarity in climate, soil conditions and socio-cultural needs, such as in Sumbawa, Flores, Sumatra and Timor islands, dry area of North Sumatra, and Sulawesi, in Indonesia. Hilly and dry areas in Eastern Thailand, Philippines, India and Africa are also similar. The TSFS technology however has global application to enhance environmental improvement, feed supply stability and energy supply.

(D) **Adoption of TSFS**

Since adoption is a process in decision making, the time factor is important. Therefore the Team sees that continued contact with farmers is a necessary step to improve adoption. Adjustment should of course be made in the TSFS technology package to make it more acceptable. The constraints in adopting the TSFS are also influenced by the availability of raw materials such as forage seeds, cutting, labour and capital.

### (E) <u>Involvement of NGOs and the Private Sector</u>

In the development of small farm, the involvement of NGOs and the private sector is encouraged by the Government of Indonesia. This is in line with the general policy in the second 25 year economic development plan, which stimulates the role of private sector.

The model being developed is the Nucleus-Plasm Relationship. The private sector ensures the delivery of inputs and output marketing. This model is well developed in poultry production, rubber and palm oil estates. In the near future, this model will be tested also to develop transmigration area.

## X. <u>PROJECT IMPACT AND THEIR IMPORTANCE TO DEVELOPMENT</u>

Impact is related to relatively permanent effects which can be sustainable. Very commonly, the impact is measured long after the project phases out from the project area. In this project evaluation it was very difficult to isolate the impact of TSFS if the analysis is conducted on whole farm basis. The multiple purpose of resource use in small farm operation makes isolation of a component effect difficult, especially if that component comprises a very small fraction of resource. Taking these aspects into account, the Team has attempted to define the impact as project benefits or short run impacts. From this point of view, the benefits can be classified as economic, technical, livestock, ecological, academic, extension and socio-cultural. The economic benefit is related to improved labour efficiency in forage collection, animal care and project income. The improvement can be observed also in farmer's skills in feed conservation, livestock performance, better feed supply and feed quality, soil fertility and environment, enhance academic capacity and farmer's knowledge, methods of extension, and farm management.

The Team found that the methodology of data collection, processing and interpretation should be sharpened to improve the technical merits of the project.

## XI. CONCLUSIONS AND RECOMMENDATIONS

The TSFS technology was considered by the Evaluation Team as biologically viable, socio-culturally acceptable, economically beneficial and ecologically and environmentally sound. However, some major recommendations were proposed as follows:

1) The cropping pattern of TSFS should be further developed in accordance to the soil fertility, as well as other agro-climatic factors.

2) The TSFS model should be relaxed according to the farmer's needs and capacity, using computer simulation and modelling which capable of differentiating dry and wet season carrying capacity.

3) There is a need to further study of the role of women in relation to TSFS and animal raising in order to obtain in-depth information concerning especially the problems and constraints facing farm women, which may be a hindrance to achieving the full benefits of TSFS utilization on farm.

4) The development of DP brochure and training to increase the involvement of the farmers should be a central activity of TSFS extension. This can be strengthened by the involvement of NGOs and other private sector groups.

5) Flexibility of the TSFS system is essential for further application and extension of the concept and technologies that have been demonstrated.

Annex

**Project Personnel**

| | | Phase I | Phase II |
|---|---|---|---|
| 1) | IMN | x | x |
| 2) | K Lana | x | x |
| 3) | M Suarna | x | x |
| 4) | W Sukanten | x | x |
| 5) | S Putra | x | x |
| 6) | W Arga | x | x |
| 7) | W Bebas (A Health) | o | x |
| 8) | N L Argani (Anthrop) | o | x |
| 9) | I N G Ustriyana (Socio-econ) | o | x |