The International Development Research Centre is a public corporation created by the Parliament of Canada in 1970 to support research designed to adapt science and technology to the needs of developing countries. The Centre's activity is concentrated in six sectors; agriculture, food and nutrition sciences; health sciences; information sciences; social sciences; earth and engineering sciences; and communications. IDRC is financed solely by the Parliament of Canada; its policies, however, are set by an international Board of Governors. The Centre's headquarters are in Ottawa, Canada. Regional offices are located in Africa, Asia, Latin America, and the Middle East.

Cover photo: D. Brian Palmer.
Shrubs and tree fodders for farm animals

Proceedings of a workshop in Denpasar, Indonesia, 24–29 July 1989

Editor: C. Devendra
© International Development Research Centre 1990
PO Box 8500, Ottawa, Ont., Canada K1G 3H9

Devendra, C.
IDRC. Regional Office for Southeast and East Asia, Singapore SG

IDRC-276e


/Trees/, /fodder/, /feed/, /animal nutrition/, /developing countries/ — /animal husbandry/, /agroforestry/, /ruminants/, /research and development/, /forage/, /case studies/, /conference papers/.


Technical editor: W.M. Carman

A microfiche edition is available.

The views expressed in this publication are those of the authors and do not necessarily reflect the views of the Centre. Mention of a proprietary name does not constitute endorsement of the product and is given only for information.
Abstract

This publication presents the results of an international meeting held in Denpasar, Bali, Indonesia, 24–29 July 1989, that focused on the use of shrubs and tree fodders by farm animals. Through 26 papers, the workshop addressed feed-resource availability, use by ruminants and nonruminants, processing methodology, economics, and development issues. These aspects and the current knowledge on shrubs and tree fodders were further highlighted by country case studies detailing prevailing situations and policy matters. A special session was held to discuss the successful development and results achieved in the three-strata forage system in Indonesia. The workshop concluded with important working group discussions on the priorities for further research and development, and on the potential for the wider use of shrubs and tree fodders in the developing world.

Résumé

Cette publication présente les résultats d’une rencontre internationale tenue à Denpasar, Bali, Indonésie, du 24 au 29 juillet 1989 et qui a porté sur l’utilisation des arbustes et fourrages végétaux par les animaux d’élevage. Les 26 communications qui y ont été présentées traitent de la disponibilité des ressources alimentaires pour les animaux, de leur utilisation par les ruminants et les non-ruminants, des méthodes de transformation, des aspects économiques et des questions du développement. Ces sujets et les connaissances actuelles sur les arbustes et les fourrages végétaux ont ensuite été étudiés plus à fond dans le cadre d’études de cas de divers pays exposant les circonstances particulières de chacun et les questions liées aux politiques. Une séance spéciale a porté sur la mise en place et les résultats des systèmes de production de fourrages végétaux en trois strates en Indonésie. L’atelier s’est terminé par d’importantes discussions des groupes de travail sur les priorités de recherche et de développement pour l’avenir et sur les possibilités d’utilisation élargie des arbustes et des fourrages végétaux dans les pays en développement.

Resumen

Esta publicación presenta los resultados de una reunión internacional celebrada en Denpasar, Bali, Indonesia, del 24 al 29 de julio de 1989, y la cual centró su atención en la utilización de forrajes elaborados a partir de arbustos y árboles para alimentar a animales de granjas. En 26 trabajos presentados al seminario, los participantes abordaron temas tales como la disponibilidad de recursos alimentarios y la utilización de los mismos por rumiantes y no rumiantes, metodologías de procesamiento y cuestiones de economía y desarrollo. Estos aspectos y el conocimiento que se tiene actualmente sobre los forrajes de arbustos y árboles se vieron subrayados aún más por estudios de casos por países en los que se detallaron situaciones existentes y cuestiones de políticas. Se celebró una sesión especial para discutir el desarrollo y resultados exitosos alcanzados en Indonesia con el sistema de forraje de tres niveles. El taller concluyó con importantes discusiones de los grupos de trabajo sobre las prioridades existentes en el campo de la investigación y el desarrollo y sobre el potencial que encierra la amplia utilización de arbustos y árboles en el mundo en desarrollo.
Contents

Foreword ................................................................. vii
Acknowledgments ....................................................... ix
Introduction ............................................................... xi

Session I: The Resources

The diversity and potential value of shrubs and tree fodders
G.J. Blair ................................................................. 2

Shrubs and tree fodders in farming systems in Asia
A. Topark-Ngarm ...................................................... 12

Major characteristics, agronomic features, and nutritional value of
shrubs and tree fodders
D.A. Ivory ................................................................. 22

Discussion ................................................................. 39

Session II: Use by Farm Animals

The use of shrubs and tree fodders by ruminants
C. Devendra .............................................................. 42

The use of shrubs and tree fodders by nonruminants
P.D. Limcangco-Lopez ............................................... 61

Toxic factors and problems: methods of alleviating them in animals
J.B. Lowry ................................................................. 76

Discussion ................................................................. 89

Session III: The Three-Strata Forage System

The concept and development of the three-strata forage system
I.M. Nitis, K. Lana, W. Sukanten, M. Suarna, and S. Putra .... 92

Research protocols appropriate to the development of methodology for
the three-strata forage system
K. Lana, I.M. Nitis, M. Suarna, S. Putra, and W. Sukanten .... 103

Socioeconomic aspects of the three-strata forage system in Bali
I.W. Arga ................................................................. 118

Communication aspects and research extension linkages of the
three-strata forage system in Bali
N.K. Nuraini ............................................................ 130

Discussion ................................................................. 136
Session IV: Country Case Studies

Availability and use of fodder shrubs and trees in tropical Africa
A.N. Atta-Krah .................................................. 140 ✔

Potential of legume tree fodders as animal feed in Central America
D. Pezo, M. Kass, J. Benavides, F. Romero, and C. Chaves ........ 163 ✔

Availability and use of shrubs and tree fodders in Pakistan
M. Akram, S.H. Hanjra, M.A. Qazi, and J.A. Bhatti ............ 176 ✔

Agrosilvipasture systems in India
P. Singh .......................................................... 183 ✔

Availability and use of shrubs and tree fodders in India
G.V. Raghavan .................................................... 196 ✔

Availability and use of shrubs and tree fodders in Nepal
N.P. Joshi and S.B. Singh .................................. 211 ✔

Availability and use of shrubs and tree fodders in Bangladesh
M. Saadullah ...................................................... 221 ✔

Availability and use of shrubs and tree fodders in Sri Lanka
A.S.B. Rajaguru ................................................ 237 ✔

Availability and use of shrubs and tree fodders in Thailand
M. Wanapat ........................................................ 244 ✔

Availability and use of shrubs and tree fodders in Malaysia
Wong C.C. .......................................................... 255 ✔

Availability and use of shrubs and tree fodders in Indonesia
M. Rangkuti, M.E. Siregar, and A. Roesyat ..................... 266 ✔

Availability and use of shrubs and tree fodders in the Philippines
L.T. Trung .............................................................. 279 ✔

Availability and use of shrubs and tree fodders in China
Xu Zaichun ......................................................... 295 ✔

Discussion .......................................................... 303 ✔

Session V: Processing, Methodology, and Economics

Opportunities for processing and using shrubs and tree fodders
M.R. Reddy .......................................................... 308 ✔

Development and evaluation of agroforestry systems for fodder production
A.N. Abd. Ghani and K. Awang .................................. 319 ✔

Economic aspects of using shrubs and tree fodders to feed farm animals
P. Amir ................................................................. 331 ✔

Discussion .......................................................... 340 ✔

Conclusions and Recommendations .................................. 341✔

Participants ......................................................... 347 ✔
The concept and development of the three-strata forage system

I.M. Nitis, K. Lana, W. Sukanten, M. Suarna, and S. Putra

Department of Nutrition and Tropical Forage Science, Udayana University, Denpasar, Indonesia

Abstract — Three-strata forage system (TSFS) refers to planting and harvesting forages so that a source of feed is available year-round. The first stratum consists of grasses and ground legumes for use during the wet season. The second stratum consists of shrub legumes primarily for use during the middle of the dry season. The third stratum consists of fodder trees for producing feeds during the late dry season. The technology developed in TSFS integrates cash-crop and livestock production. TSFS technology is transferred through training courses, the do-it-yourself approach, and regular consultation and discussion with farmers. Delayed integration with cattle, difficulties in getting grass and legume seeds, and high initial establishment costs are the major constraints in the system adopted by the farmers. TSFS increases the feed quantity and quality, the carrying capacity of the land, the supply of firewood, and farmers' income, and reduces soil erosion.

Résumé — Le régime à trois espèces fourragères (RTEF) consiste à planter et à récolter des plantes fourragères de sorte à disposer de fourrage toute l'année. La première espèce se compose de graminées et de légumineuses à utiliser durant la saison humide. La seconde comprend les arbustes légumineux qui servent surtout au milieu de la saison sèche. La troisième regroupe les arbres légumineux qui constitueront le fourrage de la fin de la saison sèche. La technologie mise au point pour le RTEF intègre la culture commerciale et la production animale. Cette technologie est transférée aux paysans au moyen de cours de formation, d'un enseignement pratique et de consultations et discussions régulières avec eux. L'application tente de ce régime au bétail, la difficulté d'obtention de graines de graminées et de légumineuses et les coûts élevés de la mise en place du régime sont les principaux obstacles à son adoption par les paysans. Le RTEF augmente la quantité et la qualité des fourrages, la capacité de charge des terres, le bois de chauffe disponible, les revenus des paysans tout en réduisant l'érosion des sols.

Resumen — El sistema de forraje en tres capas (TSFS), trata de la plantación y cosecha de forrajes de manera que haya disponibilidad forrajera durante todo el año. La primer capa consiste en gramíneas y legumbres para usar durante la estación de lluvias. La segunda capa consiste en arbustos leguminosos para utilizar principalmente a mediados de la estación de sequía. La tercer capa consiste en árboles forrajeros para producir piensos durante la última parte de la sequía. La tecnología desarrollada en el TSFS integra cosecha comercial y producción ganadera. La tecnología TSFS se adquiere mediante cursos de formación, con el método "hágalo usted mismo," y consultando regularmente a los granjeros. Las mayores limitaciones del sistema adoptado por los granjeros consisten en la integración tardía con el ganado vacuno, las dificultades para obtener semillas de legumbres y
gramíneas, y los altos costos de implantación inicial. El TSFS incrementa la cantidad y calidad del forraje, la capacidad de la tierra para nutrir el cultivo, el abastecimiento de leña y los ingresos de los granjeros, a la vez que reduce la erosión del suelo.

A survey carried out in Bali, Indonesia, showed that, during the wet season, cattle feeds consisted of 14% shrubs and tree fodders; during the dry season, the shrub and tree fodder portion increased to 32% (Nitis et al. 1980). Experiments in dryland farming area in Bali showed that Bali cattle fed 89% grasses supplemented with 11% shrubs and tree fodders gained 58% more live weight than those cattle fed grass only (Nitis 1981). This paper describes the concept and development of the three-strata forage system (TSFS) in Bali.

Background

Most farmers in Bali are smallholder traditional farmers. In the wetland farming area, cash crops are grown continuously or in multiple cropping systems, so that fallow land does not exist. In the dryland farming areas, however, cash crops are grown during the wet season; during the dry season, after the cash crops are harvested, the land is either bare or invaded by volunteer herbaceous species. Growing food crops is the main activity; livestock production, which is always integrated into the system, is a sideline activity. No land is specifically designated for livestock feeds. Ruminants are fed crop residues, grasses and shrubs grown on the edges of the field, and leaves of trees grown for fruit, shade, and protection on the land not suitable for cash-crop production. Often feed for livestock is in short supply, particularly during the dry season.

Selected castration, mass vaccination, export/interisland quota, artificial insemination, and the Kereman, PUTP (five ways to improve farm animals for slaughter), and PIR (nucleus enterprise for farmers) programs are some of the policies and programs that have been implemented to increase the production and population of Bali cattle. Planting grasses and shrub on the terrace and perimeters of the field and on the land not suitable for cash-crop production and demonstration plots to produce cuttings and seeds are some of the efforts of governmental and nongovernmental organization to increase the forage supply in Bali.

Concept of TSFS

TSFS is a technology of planting and harvesting grass, legumes, shrubs, and trees so that a source of livestock feed is available year-round. The first stratum consists of grass and ground legumes, used mainly as livestock feed during the wet season. The second stratum consists of shrub legumes, used mainly for livestock feed during the middle of the dry season. The third stratum consists of fodder trees, which are used for livestock feed late in the dry season.

By incorporating legumes into TSFS, soil fertility increases because of the nitrogen supplied by root nodules. This results in an increased nutritive value of the forage, especially the crude protein content of the foliage.
Description of TSFS

One unit of TSFS covers 0.25 ha and consists of a 0.16-ha core area, a 0.09-ha peripheral area, and a 200-m circumference (Fig. 1). The core area is located in the centre of the plot. It is planted with cash crops (e.g., corn, soybean, and cassava) commonly grown by farmers.

The peripheral area is a 5 m wide buffer zone located between the core and circumference. It is subdivided into 45-m² lots (9 m × 5 m). Each lot is planted with buffel grass (*Cenchrus ciliaris* cv. Gayndah), common stylo (*Stylosanthes guianensis* cv. Graham), green panic (*Panicum maximum* cv. Trichoglume), centro (*Centrosema pubescens*), and caribbean stylo (*Stylosanthes hamata* cv. Verano), in that order. This 900-m² improved grass and legume pasture is designated as the first stratum.

The circumference area borders the peripheral area. Fodder trees such as *Ficus poacellie*, *Lannea corromandilica*, and *Hibiscus tilleaceus* are planted at 5-m intervals along the circumference. Planted alternatively between two fodder trees are a total of 50 *Gliricidia sepium* shrubs and 50 *Leucaena leucocephala* shrubs.

![Diagram of TSFS plot](source: adapted from Nitis 1984).

Fig. 1. Circumference (A), periphery (B), and core (C) areas of a TSFS plot. The circumference of the plot is lined with trees (*Ficus, Lannea, and Hibiscus*) and shrubs (*Gliricidia* and *Leucaena*).


The core of the plot contains cash crops (e.g., cassava, peanuts, beans) (source: adapted from Nitis 1984).
The *Gliricidia* and *Leucaena* are designated as the second stratum and the *Ficus*, *Lannea*, and *Hibiscus* trees constitute the third stratum. Together, they form a hedgerow fence around the TSFS unit. One TSFS unit therefore consists of 0.16 ha cash crops for human use and 0.09 ha pasture, 2,000 shrub legumes, and 42 fodder trees to produce feeds for livestock. Cattle are integrated into the system in the 2nd year.

**TSFS application**

The application of TSFS centres on its integration of cash-crop and livestock production (Fig. 2). This integration has the following advantages:

- Management will improve because farmers usually go to their fields every day to look after cash crops;
- Livestock will not disturb the cash crop because of the protection of the TSFS hedgerow fence;
- Tethered grazing of the livestock can be minimized because TSFS will supply green feeds year-round;
- Soil fertility can be increased by regularly and evenly spreading barnyard manure from cattle in the field; and
- Cash crops and TSFS provide for the farmer’s daily needs and generates extra income and acts as insurance to meet the farmer’s unexpected expenses.

![TSFS diagram](source: Nitis, Lana, Suarna, Sukanten, and Putra 1988).
**TSFS transfer to farmers**

**Consultation with local government**

Before selecting the TSFS site, the following organizations should be consulted (Fig. 3):

- the Provincial Bureau of Planning Board, regarding the master plan of agricultural development,
- the Regency Bureau of Planning Board, concerning priorities for agricultural and livestock development, and
- the head of the village, regarding the location of specific forestry, agriculture, and livestock development programs.

Such consultation is necessary to ensure that the TSFS is in line with existing government development programs and does not interfere with other development programs in progress, and to inform officials of the concept, objectives, and benefits of the project.

**Nucleus farmers**

Farmers chosen for participation in the TSFS include

- those cultivating their own land, rather than those leasing land from other farmers,
- those who own more than 0.25 ha of land (thus, TSFS will not interfere with established farming practices).

---

**Fig. 3.** Mechanism of TSFS technology transfer (source: Nitis, Lana, Suarna, Sukanten, Putra et al. 1988). Solid lines represent direct participation, dashed lines represent indirect participation. GO, governmental organization; NGO, nongovernmental organization.
• those willing to convert 0.09 ha from food-crop to forage production, and
• those who keep livestock for savings and other unexpected expenses that cannot be met by the income from cash crops.

Demonstration plots

In selecting the site, the following points should be considered:

• The steeper the slope of the land, the less the chance for food crops to succeed and the greater the chance of forage development;
• Preference should be given to land with a live fence boundary the shrubs and trees could be used as cuttings for the TSFS; and
• Preference should be given to land currently used for food-crop production rather than to fallow land.

Training course

The training course for the farmers consists of three phases. Phase 1, carried out at the end of the dry season, describes how to select and plough the land, making lots of the first stratum and holes for the second and third strata. It also describes how to plant the grass, ground legumes, shrub legumes, and fodder trees. Phase 2, carried out in the middle of the dry season in the following year, describes how to stop the neighbour’s livestock from entering the TSFS, how to manage the seed set and the branches so that they can be used to start another TSFS in the following year, and how to refrain from cutting when the forage is nearly in short supply. Phase 3, carried out early in the wet season, describes how to cut the first, second, and third strata so that feed is available year-round. The farmers are instructed how to feed the livestock so that the diet contains balanced nutrients for growth, fattening, or reproduction, and on the possibility of conserving the excess forage in the form of silage or hay. Farmers are also taught the importance of animal health and disease prevention.

Do-it-yourself approach

The objective of dividing the training course into three phases is to ensure that the farmers have the information fresh in their minds when working in the field. Depending on the time available to members of the TSFS team, farmers get attention as a group or individually. The team shows the farmers what to do and asks the farmer to follow by example. When it is apparent that the farmer has understood, the farmer is encouraged to complete the work. A flexible deadline for the completion of the work is arranged.

The team does not necessarily stay on the site all the time; their presence may make some farmers feel uneasy. When revisiting, the team does not directly pinpoint any mistakes that have been made; rather more emphasis is placed on the good things that have been achieved.
Family participation

Even though only the head of the family participates in the training course, the TSFS team should encourage all family members to participate in fieldwork. Such family participation will develop a sense of belonging, so that when the head of the family is attending other functions, the other family members will take the responsibility of the TSFS activity. The role of children should not be underestimated. They will talk with the other children at school and make them aware that grasses, legumes, shrubs, and trees should not be cut indiscriminately, as is done in the public field.

Comparative group control

Some farmers may show interest in TSFS but not have enough people to do the work. These farmers practice the traditional, non-three-strata forage system (NTFS). They are usually good watchers and may pick a few components of the TSFS technology that are suited to their specific location. These farmers may be used as a comparative control to monitor the extent of technology transfer to the TSFS farmers.

Contact person

To attend to the day-to-day activities of farmers and to bridge the communication gap between the farmers and the TSFS team, a contact person in the TSFS location is needed. This contact person should be well trained, conversant with the various technical aspects of agriculture, able to make decisions, act quickly, and report immediately to the team. The team should ensure that the contact person does not become too bossy for the farmers.

Farmers’ group formation

If a farmers’ group has already been formed, either a member of this group or members of some other groups can form a TSFS group. If no farmers’ group exists, a TSFS farmers’ group should be formed. The group should consist of farmers actively participating in TSFS as well as those interested in TSFS (NTFS farmers).

The TSFS activity should only be part of the group activities. Family planning, child care, health programs, and home industry should also be included. The farmers’ group may set rules and regulations and enforce them by setting a penalty for those who do not follow these regulations.

Guidance and consultation

The TSFS team and the farmers should meet regularly to discuss any problems that have arisen and seek solutions that are beneficial to the farmers. Problem solving through personal contact is preferable to problem solving by vote. The team should listen, consider, and acknowledge the farmers’ suggestions.
Farmers’ opportunity for selection

Using three varieties of grasses, three varieties of legumes, two varieties of shrubs, and three varieties of trees, and planting them individually, will allow the farmer to select the plant best suited to the location. Farmers can also select the cattle or goats to raise in the system. If farmers need draft power, cattle are appropriate. If farmers need quick cash, goats are more appropriate. Planting arrangements can also be varied to suit the farmer’s needs. For fence lines, *Gliricidia* and *Lannea* are appropriate.

Incentives to farmers

The following incentives are given:

- In each 0.25-ha plot, the farmer loses 0.09 ha for food-crop production the farmer is compensated for this lost production.

- Farmers must use the 0.09-ha area and make holes for the shrub and trees seeds and cuttings are given free of charge to the farmers.

- When cattle and goats are sold, each farmer receives 50% of the profits after the initial cost of the livestock has been deducted from the cost of the animals.

Observing local customs and traditions

When starting a new component technology, farmers should be consulted to avoid any inconvenience to them or their surroundings. For example, some farmers prefer *Ficus* to be planted away from the house because its shallow root system may interfere with the house’s foundation. Farmers will not castrate cattle during the wet season because flies will infect the wound. An offering is made in Bali before beginning castration.

The team attitude

Each team should bear in mind the following points:

- Their function is to solve farmers’ problems, not to solve the problems in the research project.

- The farmers have the knowledge, the team has the science.

- Farmers must feel that the team belongs to them, not that they belong to the team.

Governmental and nongovernmental participation

Apart from consulting government officials regarding TSFS, the team should ask governmental and nongovernmental organizations to visit the site and talk to the farmers. Interested governmental organizations will help to spread the idea of TSFS. When appropriate, newspaper, radio, and television should be used to make other farmers aware of the TSFS technology (see Fig. 3).
Constraints in the adoption of TSFS

In transferring TSFS technology to the farmers, three constraints merit special attention (Nitis et al. 1986). First, farmers must wait 1 year for the establishment of the first and second strata and 3 years for the establishment of the third stratum. However, the loss of 0.09 ha for cash-crop cultivation will be compensated for by the sale of cattle. Second, drought-resistant grasses and ground legumes are difficult to obtain when TSFS is newly introduced to another area. However, once they are established, they become a source of planting material and seeds for other farmers interested in adopting TSFS technology. Third, the initial establishment cost of 150–200 USD is expensive for farmers. Through special bank loans and cooperative arrangements, however, such an investment can be made without upsetting the budget of farmers.

Improving the TSFS concept

To improve the TSFS concept, the following developments have been made:

- ‘Graham’ stylo, a volunteer cultivar, is replaced with *Urochloa mosambicensis*, which is more persistent.
- *Centrosema*, a creeping legume, is planted with *Stylosanthes scabra* cv. Seca to act as climber for the *Centrosema*.
- Because *Leucaena* yield is low (as a result of infestation by *Heterphsylia cubana*), *Acacia villosa* is sown along the *Leucaena* row.
- Because terraces could reduce the use of the sloping land, shrub legumes are planted along the lower side of the terrace at a spacing of 1 m as well as a strip of mixed grass and legume 1 m wide.

Expected outcome

The expected results of TSFS are as follows:

- decreased cash-crop yield (the land used to grow cash crops is reduced to 0.16 ha from the 0.25 ha provided);
- increased livestock feed (each unit of TSFS consists of 0.09 ha improved pasture, 2,000 shrub legumes, and 42 fodder trees);
- improved livestock feed (ground and shrub legumes are included in the system);
- increased carrying capacity of the land (extra forages are available);
- faster cattle growth, particularly during the dry season, when feeds are usually in short supply;
- increased firewood supply (branches of shrubs and trees are not fed to livestock);
• reduced soil erosion (first, second, and third strata reduce rainwater runoff);
• less time spent managing cattle (feed is always available);
• increased bee keeping and honey production (plants in all three strata do not flower simultaneously);
• increased "Kampung" chicken production (white ants roaming on the leaf debris, grass seeds, and legume seeds are sources of protein and carbohydrates for the poultry);
• increased farm income; and
• greener countryside (all strata are green almost year-round).

Extent of TSFS adoption

Most farmers will find no difficulty in adopting the TSFS technology. The classification of TSFS into core, peripheral, and circumference areas should be familiar to the farmers they usually construct a live fence around the field and cannot plough close to the fence, therefore, a belt of native grass is always found between the cash crop and the fence. Also, using two grass and three legume species for the first stratum, two shrub legume species for the second stratum, and three fodder tree species for the third stratum will give the farmer ample opportunity to select preferred species.

When initiated in 1984, 32 TSFS units were established. In 1986, the Provincial Bali Government initiated 30 TSFS units in east Bali (Nitis et al. 1987). In 1987, the Daya Pertiwi Foundation initiated 12 TSFS units in Nusa Penida (Nitis, Sukanten et al. 1988); in October 1988, they increased this total by another 37 units. The Foster Parent Plan International Bali initiated 30 TSFS units in east Bali in October 1988. The Badung regency plans to initiate 34 TSFS units in south Bali in 1989. TSFS could also benefit farmers in other parts of Indonesia as well as the rest of Asia and in Africa.

References


the role of ASAIHL universities in the transfer of technology. University of Indonesia, Jakarta, Indonesia. 21 pp.


