



Editorial

This seventh issue of CIEPCA's newsletter also includes articles on forage production and animal nutrition, as well as agronomic and socioeconomic reports. We wish to thank our readers who sent us their findings on cover crops activities. We are also grateful to Dr. John P. Bishop who agreed to share with our readers his experiences about his project in central Liberia.

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FORAGES AND ANIMAL FEEDING REPORTS

The potential contribution of selected forage legume pastures to cereal production in crop-livestock farming systems

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The potential of 3-year-old grazed pastures of *Stylosanthes hamata*, *Chamaecrista rotundifolia* and *Centrosema pascuorum* to contribute to subsequent maize production was investigated in subhumid Nigeria in 1993. All three legume pastures had the ability to give better maize grain yields than native pasture but this was significant only for *Stylosanthes hamata* and *Chamaecrista rotundifolia*. For the legume species, maximum yield of maize per kg of N applied was attained at 60 kgN/ha. The subsequent yields of maize could be related to the legume species used, pasture management, and the length of the fallow period. *Centrosema pascuorum* behaved as an annual, and as such there was little legume present after 3 years; crop yield was therefore relatively low. Nevertheless, this species could be useful in 1-year fallow/pasture situations. Maize cropping was economically viable for legume plots only with 60 or 120 kgN/ha and not for native pasture. There were no significant differences in the time required to till or to weed legume pastures as compared with native pasture. Forage legume pastures could also have a positive effect on maize residue yields which represent a fodder resource in addition to the herbage understorey remaining after cropping, the quality of which could be enhanced by the presence of the forage legumes. The use of forage legumes for the promotion of both crop and livestock production in sustainable agricultural systems is discussed. The results of the study are used to highlight the importance of selecting the appropriate legume species, pasture management practices, and duration of fallow period in relation to the prevailing farming system to maximise benefits from the legumes.

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Evaluating selected forage legumes for livestock and crop production in the subhumid zone of Nigeria

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A programme of forage legume evaluation was developed at the International Livestock Centre for Africa's (ILCA) subhumid research site in Nigeria from 1985 onwards. Evaluation included monitoring herbage and seed yields, incidence of diseases/pests, regeneration ability and persistence for three growing seasons. This was followed by an *in situ* bioassay to determine the direct effect of the sown legumes on maize (*Zea mays* L.) production in the absence of added nitrogen.

The results for selected accessions from introductions received in 1987 and 1988 are presented. *Stylosanthes guianensis* CIAT184 (ILCA164) and ILCA15557 and *Aeschynomene histrix* ILCA12463 were promising both in terms of biomass production (up to 9.4, 3.4 and 9.6 t/ha respectively) and quality (all had crude protein values of 11 % or more), and in terms of beneficial effects for maize production (all plots gave significantly more grain than those with no legume, reaching over 3 t/ha for maize grown on plots after *S. guianensis* ILCA15557). The use of such appropriate forage legumes to enhance both livestock and crop production in a sustainable farming system is recommended.

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Characterization of a germplasm collection of the tropical pasture legume *Centrosema brasilianum* in subhumid West Africa

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The available world collection consisting of 257 accessions of the tropical pasture legume *Centrosema brasilianum* (L.) Benth. was assessed between 1993 and 1995 in northern Nigeria to complement existing knowledge on the genetic diversity of this species and to identify accessions with high agronomic potential for subhumid West Africa. The excellent nutritive value and good dry matter productivity of *C. brasilianum* and its outstanding ability to remain green over extended dry periods confirmed its potential as an important forage resource, especially for the dry season, and indicated

its possible role in soil conservation. Two distinct groups, comprising 10 and 11 accessions, were identified for further evaluation in short fallow and pasture systems, respectively. Accessions in the first group had a fast establishment, very high yields in the establishment year and good drought tolerance but yields were low to average in subsequent years. Accessions in the second group had sustained high yields under grazing, a high competitive ability, and good drought tolerance.

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Grazing lands of the Guinea zone in Bénin under the threat of *Chromolaena odorata*

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Chromolaena odorata is a plant of the family of the Asteraceae. It originated from the West Indies and equatorial America and was first introduced as a cover crop in Asia by the turn of the 19th century, and in Africa between 1920 and 1940 (Lavabre, 1988). *C. odorata* was introduced in the Guinea zone in Bénin in the seventies and its geographical distribution is widening. Among its benefits are its ability to control soil erosion, its healing and aesthetic virtues, and its soil fertility enhancement effect. According to Autfray and Gbaka (1998), "*Chromolaena odorata* has a very high mineral content; as high as that of leguminous forage crops when it comes to leaves". So far as its pastoral value is concerned, it is one of the most frequently refused plants in pastures degraded by severe weed infestation in the Guinea zone in southern Benin. In this study, weed infestation is the process whereby refusals (species not normally grazed by grazing cattle in the study area) invade and grow in the pastures. The study covered 9 types of pastures in the sub-prefectures of Abomey-Calavi and Allada in southern Bénin. The aim was to work out the amount of refusals, their rate of recovery, the rate of weed infestation, and its impact on pasture quality. Pastures were sampled based on the following criteria: prevailing species, soil type, vegetation type, density of forage crops, grazing pressure, age, history, and mode of pasture management. Grazing was monitored on two herds of cattle of 28 and 65 heads respectively. Each time, grazed and refused species were recorded. Phytosociological and linear readings were taken inside 15 small experimental plots of 25 m x 25 m. The phytomass

turned out was assessed at the peak of biomass production using down-to-ground pruning method.

The results showed that where *C. odorata* had a high rate of recovery, no other species was found. Most of the other species were found only in spaces not covered by *C. odorata*. These spaces are used as feeding passage by the cattle. In less degraded pastures, *C. odorata* colonies are reduced to a few isolated individuals. In fact, *C. odorata*, as a result of its high rate of recovery, smothers the other species thus depriving them of light. This is the reason why other species are generally few or absent under *C. odorata* bushes. The highest rates of weed-infestation and the lowest pastoral values were generally found with pastures where *C. odorata* was the most common refusal (Holou, 1998). Refusal dominance leads, among other things, to lower productivity of forage species. One good illustration of such situation is provided by the pasture of *Brachiaria ruziziensis* and *C. odorata* where the phytomass of *Brachiaria ruziziensis* (a good gramineae) dropped to 0.3 g DM^a/m² as a result of the weight input by 4 refusals, especially by *C. odorata* (150 g DM/m²). In areas with a lower weight contribution by *C. odorata* (18 g DM/m²), the phytomass of *Brachiaria ruziziensis* stood at 375 g DM/m². Furthermore, early in the rainy season, grasses, namely *Brachiaria ruziziensis* and *Panicum maximum* which are the most common forage species, are also the most grazed by the animals. Over this period, animals move easily through the bushes of *C. odorata* which they avoid. Access to the pastures is made difficult by the bushy growth of *C. odorata* on old fallow lands which are thus abandoned by the animals for younger fallows that they subject to high grazing pressure. In abandoned pastures, *C. odorata*'s refusals outgrow forage species which eventually disappear. Furthermore, one of the drawbacks of weed-infestation is the risk of poisoning run by the cattle which graze on degraded pastures (Boudet, 1991).

^a DM: Dry Matter

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AGRONOMIC REPORTS ON COVER CROPS

Tephrosia vogelii

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The common names of this plant are Kibazi, Mtupa (Swahili); hu Kataiyu (Lao) Vogel's Tephrosia (English). The tree is grown in South-east Asia as a leguminous shrub tree.

Tephrosia vogelii is a soft woody branching herb, having a dense foliage growing to a height of up to 4m high. The stem and branch are tomentose with long and short white or rusty brown hairs.



Tephrosia vogelii Hook. f.

The legume thrives in altitudes up to 2100 m where the mean annual temperature is 12 - 27 degrees C and mean annual rainfall is 850 - 2650mm. It grows well on andosols and loams with pH 5 - 6.5 and is tolerant to poor soil with low pH. It can grow in widely varying habitats, including Savannah-like vegetation, grassland, forest margins and shrubland, wasteland and fallow fields.

The shrub tree is propagated by seed. The rate of sowing is about 7.5 - 8.6 kg/ha at 1 metre in rows of 1.75 metres apart. If the seeds are broadcast, then the rate of sowing should be 8 - 13 kg/ha. The germination of the seed is enhanced by soaking them for 20 minutes in concentrated sulphuric acid followed by immersing in water at 28 degrees C for 2 hours. The alternative is to soak the seeds in water overnight.

The tree grows rapidly to 2 - 3 m in 7 months. The shrub yields large amount of green material and withstands several loppings. After 6 months of growth, the average green material per hectare is above 27.41 t.

The yield of nitrogen is about 112 kg/ha. This shrub is tolerant to drought and strong winds.

Tephrosia vogelii has several uses. It is used as a shade or shelter. In this region, it is grown as a windbreak and temporary shade crop in cocoa, coffee, tea, rubber, and cinchona plantations. It is also used as green manure.

The nitrogen content is 3.7 g/100g of dry matter in plants 2 - 3 months old. Its various coloured flowers make it suitable as an ornamental. The dense growth makes it suitable for use as a hedge plant. The compound leaves contain the highest concentration of rotenoids, which makes it useful as an insecticide. Its compounds are effective against a number of different pests. It has been tested effective against termites, citrus aphids, red spider mite). Trials have shown that for killing insects, 20 g of leaves for every 100 ml of water. The crushing of the leaves need not be done perfectly. A plastic bag and rocks can be used. After soaking for 2 hours, filter the suspension through a cloth and use directly in a sprayer.

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Organic matter dynamics in mixed-farming systems of the West African savanna: a village case study from south Senegal

Raphael MANLAY

Organic matter is a multi-purpose tool in West African smallholder mixed-farming systems, but its supply has been decreasing for several decades. To assess the viability of a mixed-farming system of south Senegal, carbon (C), nitrogen (N) and phosphorus (P total and available in soil and noted POD) budgets (stocks and flows) were thus quantified. The village territory of the study showed a ring-like organisation with intensification of fertilisation and cropping practices from the periphery (bush ring) to the compounds (compound fields). Stocks in plant and soil averaged 54.7 tC, 2.63 tN and 43.5 kgP ha⁻¹ in old fallows. They were 97, 29, and 251 % higher than in the bush cropped fields, plant biomass accounting for nearly all of the difference. C, N, and P amounts recorded in the soil of compound fields were higher than those of the bush field, but the increase was restricted mainly to the 0 - 10 cm layer. However, the rather weak response of local sandy soils to management can be interpreted only by reassessing the bio-thermodynamical signification of soil organic carbon cycling in the maintenance of the integrity of local agroecosystems. Manageable stocks of the whole village territory were estimated at 29.7 tC, 1.52 tN, and 28.6 kgP ha⁻¹ in 1997. Carbon was stored mainly in soil. Livestock, crop harvest, and wood collecting were responsible for respectively 59, 27, and 14 % of the C uptake on the village territory. As a

result, large C flows were set towards the compound ring (3.8 tC ha⁻¹ y⁻¹). N and P depletion of the system amounted to 4 kgN and 1 kgP ha⁻¹ y⁻¹, suggesting that the system was close to nutrient balance. Under current demographic growth rate, C depletion may reach 0.38 t ha⁻¹ y⁻¹ and C demand may double during the next three decades. Without any intensification of farming practices, the viability of the system might soon be called into question.

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Multipurpose legume-based rotations to improve sustainability and profitability of garden and field crop production on less fertile lands in the humid tropics

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Shifting field cultivation is the dominant farming system on less fertile lands in the humid tropics. Throughout the humid tropics, however, the practice of shifting field cultivation is changing rapidly due to increased population growth rates and immigration. As human population and expectations increase, traditional bush fallows are shortened, accelerating land-resource degradation at an alarming rate, and critically decreasing basic food crop yields precisely as needs are increasing. Solutions to these problems are some of the most difficult challenges facing tropical agriculture today.

Multipurpose legume-based rotations (MLRs) can help improve chemical, physical, and biological properties of soil, as well as reduce weed populations, plant pathogens, and soil erosion (six components of land-resource degradation in the humid tropics). Garden and field crop MLRs at the Ganta Stations use four each of the following six local legumes: *Arachis hypogaea*, *Vigna unguiculata*, *Phaseolus lunatus*, *Cajanus cajan*, *Mucuna pruriens*, and *Gliricidia sepium*. The MLRs provide food, feed, fertility, forage, and fuelwood; and also help control weeds, pests, diseases, and soil erosion. These MLRs also require little purchased input and low management skills.

Garden crop / multipurpose legume-based rotations

Year 1. At the first rains, plant a mix of groundnut *Arachis hypogaea* (0.25 m x 0.25 m) and pigeon pea *Cajanus cajan* (2 m x 2 m). After five months, harvest the groundnut. Then, scratch the harvested ground and broadcast cowpea *Vigna unguiculata* between plants of the fast-growing legume shrub *Cajanus* (2 m x 2 m). After three months, harvest the grain

legume *Vigna*. Then, during the dry season, harvest the “food-feed-fertility-forage-fuelwood” legume *Cajanus*. The multipurpose cover-legume *Cajanus* also helps control weeds, plant pathogens, and soil erosion.

Year 2. At the first rains, plant a mixture of corn (0.5 m x 0.5 m) and the green-manure/cover-crop *Mucuna pruriens* (1 m x 1 m) between *Cajanus* (2 m x 2 m). After harvesting the corn, allow *Mucuna* to climb the fast-growing legume shrub *Cajanus* to increase *Mucuna* seed production. During the dry season, harvest the “food-feed-fertility-forage-fuelwood” legume *Cajanus* seed and the “forage-fertility” legume *Mucuna* seed. The multipurpose cover-legumes *Cajanus* and *Mucuna* also help control weeds, plant pathogens, and soil erosion. At the end of the dry season, slash-and-mulch the *Cajanus* and *Mucuna* plants.

Year 3. At the first rains, plant a mix of the traditional garden crops (e.g. okra, eggplant, lima bean, pineapple, sweet corn, squash, sweet potato greens). At the end of the dry season and after harvesting of garden crops, slash-and-mulch crop residues, and with the first rains repeat the above three-year rotation.

Field crop / multipurpose legume-based rotations

Year 1. At the first rains, plant a mixture of traditional grain crops (e.g. rice, corn, lima beans) and traditional farinaceous crops (e.g. cassava, plantain, sweet potato, yam, eddo). After the harvest of traditional grain crops, plant a mixture of the grain legumes cowpea *Vigna unguiculata* (0.5 m x 0.5 m) and pigeon pea, *Cajanus cajan* (1 m x 1 m), plus pawpaw *Carica papaya* (2 m x 2 m). After three months, harvest the grain legume *Vigna*. Then, during the dry season, harvest traditional farinaceous crops.

Year 2. At the first rains, plant a mix of bush-bananas *Musa spp.* (4 m x 4 m) and the fast-growing legume tree *Gliricidia sepium* (8 m x 8 m) in with the fast-growing legume shrub *Cajanus* (1 m x 1 m). Also, continue to harvest the plantain, eddo, pawpaw, and pigeon pea.

Years 3 and 4. Harvest the “food-feed-fertility-forage-fuelwood” legume *Cajanus*, and the “poultry/swine energy-feeds” *Musa spp.* and *Carica papaya*. *Musa* and *Carica* also aid land restoration by accumulating large amounts of organic matter. The multipurpose cover-legumes *Cajanus* and *Gliricidia* also help control weeds, plant pathogens, and soil erosion.

Years 5 and 6. Harvest the “poultry/swine energy-feed” *Musa spp.* and the “forage-fertility-fuelwood” legume *Gliricidia*. At the end of the sixth dry season, slash and mulch the *Musa*, *Cajanus*, and *Gliricidia* plants and with the first rains repeat the above six-year rotation.

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Survey on insects associated with selected legume cover crops in the forest zone of southern Cameroon

Maurice Tindo

Leguminous cover crops are increasingly used in fallow systems to provide nutrients to the soil, protect soil surface against erosion, and prevent the invasion of noxious weeds. These characteristics have triggered in recent years considerable research work on leguminous cover crops as an alternative solution for chemical inputs in agrosystems. About 80 accessions and 50 species of legumes are in the screening process by IITA scientists at the Humid Forest Ecoregional Center (HFC) at Mbalmayo, for their performance in this agroecozone (see CIEPCA Newsletter No 4, page 8). Since early April 1998, scientists at the HFC are investigating the insect fauna associated with the most promising legume cover crops. Next to steady field observations in different sites, a reference collection was established by net sweeping adult insects and by rearing immature stages in the laboratory, expecting the emergence of natural enemies. The damage caused by the most important species is being assessed in the field. The identification work is carried out in close collaboration with the IITA insect museum at Cotonou Republic of Benin.

The aim of this study is to provide some baseline data yet entirely lacking for insects associated with cover-crop legumes in West Africa. Furthermore, emphasis will be put on the role of these plants as potential refuges for beneficial insects or as alternative hosts for pests of food crops in the same agroecosystem. This work will help to draw recommendations for the use of the most suitable cover-crop legumes in this ecozone.

Preliminary data indicate that many of the insect species found on the legumes studied are commonly known as pests of grain legumes such as cowpea and soybean. For instance, during the plant's flowering and podding phase, the alydid *Riptortus dentipes* was the most common bug, followed by the coreid *Cletus sp.* and the pentatomids *Atelocera spinulosa*, and *Acrosternum pallidoconspersum*. These insects were observed to feed mainly on the flower's base. Thus, they appear to be responsible for the seed sterility of *Tephrosia candida*, a fact that has been reported by IITA scientists at the HFC to limit the multiplication of this plant in the humid forest zone. Further pests of economic importance such as the maize ear borer *Mussidia nigrivenella* was also observed to bore the pod of *Canavalia sp.* and *Mucuna sp.* (see also Schulthess and Setamou, CIEPCA newsletter No 4, page 2).

On the other hand, a new parasitoid of the cowpea flower thrips *Megalurothrips sjostedi*, was encountered for the first time around Yaoundé in 1998 and tentatively identified as *Ceranisus femoratus* Gahan (Hym., Eulophidae). This parasitoid has been found to survive very well on *Centrosema pubescens*, *Diochlea guianensis*, and *Tephrosia candida*, but not on *Canavalia* sp. where an unidentified thrips species is predominant. After obtaining standard import permits, *C. femoratus* was brought to the insectaries of the IITA station in Cotonou, and was subsequently released in experimental plots where it is now established (Tamò, pers. comm.). The *Lablab purpurea* pod borer, *Sphenaches* sp. has been found controlled by a *Tropimeris* species at the rate of 90%.

Some complementary work is being presently carried out for the finalization of a detailed report.

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OTHER REPORTS ON COVER CROPS

Farmers' perceptions of adoption of soil fertility technologies

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A case study on the adoption of cover crops such as *Mucuna* (*Mucuna pruriens* var. *utilis*) and *Canavalia* (*Canavalia ensiformis* (L) DC.) and animal manure was carried out to examine the farmers' perception on soil fertility technologies in three (3) districts in Brong Ahafo Region in Ghana. Farmers compared these technologies to chemical fertiliser, which is already well known to them. Farmers ranked *Mucuna* and *Canavalia* technologies higher than chemical fertiliser because of low cost, long-term improvement of soil fertility, weed suppression and easy seed production. Chemical fertiliser and animal manure however, ranked higher than *Mucuna* in terms of short-term improvement on soil fertility. The adoption rate of these technologies increased from year to year in the districts. Some farmers however considered the difficulties to intercrop *Mucuna* well with any other crop as the only constraint to adoption due to its' entangling manner. Farmers' perception of the problems associated with each of the technologies were as follows; *Mucuna* require land for a season without cropping and the seeds have no economic use. *Canavalia* seeds are difficult to acquire. Animal manure is work intensive thus difficult to transport and apply and also enhances weeds growth. Chemical fertiliser is expensive and enhances weeds growth.

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Integration of *Mucuna* improved fallow systems into cropping systems of the Brong Ahafo Region (Ghana)

Heinz Loos, Wolfdieter Zschekel, Simone Schiller and J. Anthofer

Improved fallow systems with *Mucuna pruriens* have been introduced in the Brong Ahafo Region (Ghana) to address problems of declining soil fertility and increasing weed load. For the forest zone with its predominant plantain-based mixed cropping system, the use of *Mucuna* as a cover crop is limited. The intercropping of *Canavalia* has a better potential. Here *Mucuna* may be used as a cover crop in older plantain stands or in rotation with sole cropped rice for weed control. In the savannah zone, annual rotations with long season *Mucuna* and maize or yam can be used to improve soil fertility and control weeds. Establishment problems may occur in areas of erratic rainfall. For the transitional zone with two systems of *Mucuna*, improved fallow has been successfully introduced. Maize grown after a *Mucuna* fallow yielded between 30 - 70 % more than maize after natural fallow and the weed load was significantly reduced requiring only one weeding as compared to three weedings. There is a good potential adoption for the technology, since requirement for land access, capital investment, and labour is relatively low. More experimentation with *Mucuna* varieties of various growing periods is necessary to adapt to local rainfall pattern and conditions.

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Decision support system: feasibility of legume use

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IFDC-Africa's Programme for Integrated Intensification (PII) is developing a decision support system for guiding the choice when and where to promote or to use leguminous species. Please test the tool (see following paragraphs) and inform us about its deficiencies, giving us also the context under which it has been used (see our co-ordinates above). We would also like to know if you are interested to join forces with us and improve the tool together.

Please let us know if you are interested in other decision support systems IFDC is developing. One is related to the

economic feasibility of fertiliser use (DSS-FFU), and can be drawn upon to obtain prices of crops and fertiliser in West Africa as well as for dose: effect relationships. IFDC's DSS-PRU (phosphate rock use) will be the tool for making a choice between P-fertiliser or phosphate rock as source of P in stimulating legume production and its N-fixation and crop production in general.

Send your reaction to PII (our Programme for Integrated Intensification) using our address above.

Tool

1. N deficient soils?

- No: legumes no specific benefit
- Yes: see 2.

2. Problems caused by N deficient soils?

- Human nutrition protein deficient: see 3
- Livestock fodder protein deficient: see 5
- Crop growth N deficient: see 11

3. Human nutrition protein deficient and 1 kg of fertiliser-P cheaper than 3.5 kg of fertiliser-N?

- No; livestock intensification using NPK fertilised "grass" recommended;
- Yes: see 4.

4. Human nutrition protein deficient and 1 kg of fertiliser-P respectively cheaper than 11 kg of fish or poultry, or 5 kg of meat?

- No; legumes no specific benefit unless the answer on question 6 is positive
- Yes: promote production of leguminous grain crops.

5. Livestock fodder protein deficient and overall fodder availability not limiting?

- No: overall fodder availability limiting: livestock intensification using NPK fertilised "grass" recommended
- Yes: see 6.

6. N/MOD ratio of fodder < 0.017 and 1 kg of fertiliser-P cheaper than 3.5 kg of fertiliser-N?

- No: livestock intensification using NPK fertilised "grass" recommended;
- Yes: see 7.

7. Fish and poultry highly preferred above meat?

- Yes; legumes no specific benefit
- No: see 8.

8. Use of legumes to improve fodder status to be promoted; natural vegetation dominated by annuals and dynamic?

- Yes: annual fodder crops recommended
- No: see 9.

9. Use of legumes to improve fodder status to be promoted; natural vegetation dominated by perennials and relatively stable; a lot of space and pastoral production systems?

- No (limited space, agro-pastoral systems): annual fodder crops recommended
- Yes: see 10

10. Use of legumes to improve fodder status to be promoted; natural vegetation dominated by perennials and relatively stable; a lot of space and pastoral production systems; environment prone to erosion and/or soil very P-deficient?

- Yes: leguminous fodder banks recommended
- No: introduction of legumes in rangeland, suppressing woody species recommended.

11. Crop growth N-deficient and 1 kg of fertiliser-P cheaper than 3.5 kg of fertiliser-N?

- No: crop intensification using NPK fertilised crops and integrated nutrient management recommended
- Yes: crop intensification using P fertilised leguminous crops and integrated nutrient management recommended; see also 3 and 5.

ANNOUNCEMENTS

Fallow in tropical Africa

Christian Floret and Roger Pontanier

Until quite recently, the system which consists in alternating a cropping phase with a fallow phase had functioned adequately in the tropics of Africa. Today, the situation is somehow different as population figures are rising and people are settling, causing a rapid expansion of farmlands to the detriment of fallowed lands. In future, it would be proper to modulate this traditional system and envisage alternative methods.

This work is a compilation of part of the papers presented at a seminar held in Dakar from 13 through 16 April 1999. A second volume of the same work released by the same publisher runs through ten chapters on various themes, namely the role and production functions of traditional fallow in tropical Africa, the importance of improved fallows and the alternative methods that are being abandoned. This synthetic compilation on the fallow system and its future by authors from different specialized areas covers biological, agronomic as well as socioeconomic aspects. It provides a state-of-art of knowledge about the agrarian transition from fallow to continuous cultivation. This second volume should be consulted together with the first volume.

La jachère en Afrique tropicale, *Ed. sci. Christian Floret et Roger Pontanier* Vol.1 Actes du Séminaire, 777 p ; Vol.2 De la jachère naturelle à la jachère améliorée. Le point des connaissances, 339 p. John Libbey Eurotext ; Paris.

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Eighteenth COLUMA conference international meeting on weed control and soil management

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