



Centre d'Information et d'Échanges sur les Plantes de Couverture en Afrique  
Center for Cover Crops Information and Seed Exchange in Africa

08 B.P. 0932 Tri Postal, IITA, Cotonou République du Bénin; Tel: (229) 350188 Fax: (229) 350556 E-mail: ciepcac@cgiar.org

## CIEPCA NEWSLETTER

NUMBER 5

APRIL 2000

### Editorial

There is increased understanding that the benefits of cover crops (CC) do not only apply to soils and weeds but also to animals. This edition of the CIEPCA Newsletter carries summaries of articles on both soils and animal feed as well as some thoughts contributed by scientists and extension officers on the economic aspects of CC utilization.

We will be happy to receive through various means, including internet, summaries of articles published in journals or from your literature review, so long as they deal with various aspects of CC that could be published in future editions of our Newsletter. For this purpose, kindly remember to send us e-mail addresses and fax numbers of the journals to enable us obtain relevant authorizations for reproducing material.

### COVER CROPS AND ANIMAL PRODUCTION

#### Anti-nutritional factors in forage legumes

R. Kumar<sup>1</sup> and J.P.F. D'Mello<sup>2</sup>

<sup>1</sup>Central Sheep and Wool Research Institute, Avikanagar (Via Jaipur), Rajasthan 304 501, India;

<sup>2</sup>The Scottish Agricultural College, West Mains Road, Edinburgh, EH9 3JG, UK

Animals are primarily sustained by plants with the photosynthetic and the nitrogen fixation capacity that convert inorganic carbon, hydrogen, oxygen and nitrogen into complex organic compounds such as carbohydrates, fats and proteins which are used as nutrients by animals. However, plants did not evolve to serve animals. Indeed, a primary feature of plant metabolism is directed at ensuring survival and dissemination of the plant species. Therefore, plants have acquired the capacity to synthesize compounds that are deleterious and which protect them from predators such as bacteria, fungi, insects or other animals. Although some of these compounds are known to evoke an immediate violent reaction, much more subtle effects are commonly noticed due to prolonged ingestion. Such effects might include reduction in feed intake, diminution of digestive process or metabolic utilization of feed resulting in an inhibition of growth, a goitrogenic response or damage to vital organs. Therefore, these compounds are termed as 'anti-nutritional factors' or 'deleterious substances'. Being an anti-nutritional factor is not necessarily an intrinsic characteristic of the compound but may depend upon the digestive process of the ingesting animal; e.g. trypsin inhibitors, the anti-nutritional factors for monogastric animals, do not exert adverse effects in ruminants because they are degraded in the rumen.

Both pasture and browse species of tropical legumes are attributed with deleterious properties in livestock nutrition, either via direct toxicity or through reduced palatability (Skerman *et al.*, 1988). However, considerable variation exists among members of a single species in their propensity to elicit adverse effects. Thus, of the three *Aeschynomene* species cited by Skerman *et al.* (1988), only *Aeschynomene indica* has been associated with direct toxic effects, causing mortality in farm livestock. Other pasture species listed as toxic included *Canavalia ensiformis* and *Macroptilium lathyroides*. In addition, a significant number of pasture legumes catalogued by Skerman *et al.* (1988) were associated with moderate to low palatability, particularly as regards young plants, with livestock requiring a period of adaptation prior to an improvement in consumption. A number of species were also linked with the incidence of bloat and taints in milk. Among the pasture leg-

### In this issue

#### COVER CROPS AND ANIMAL PRODUCTION

Anti-nutritional factors in forage legumes .....	1
I know the protein content of a dry forage. How do I calculate what it would be when I feed it green .....	3
Mucuna in farming systems in northern Benin: Approaches and management alternatives .....	3
Performance of <i>Stylosanthes hamata</i> var. <i>Verano</i> .....	4

#### OTHER REPORTS ON COVER CROPS

Characterization of the seed proteins of velvet bean ( <i>Mucuna pruriens</i> ) from Nigeria .....	5
Studies on chemical composition and antinutritional factors in three germplasm seed materials of the tribal pulse, <i>Mucuna pruriens</i> (L.) DC .....	5
Farmers' perceptions and the dynamics of adoption of a resource management technology: the case of <i>Mucuna</i> in southern Benin, West Africa .....	5
Management of cogon grass ( <i>Imperata cylindrica</i> ) with velvetbean ( <i>Mucuna pruriens</i> var. <i>utilis</i> ) and herbicides .....	5
The economics of soil conservation in developing countries: The case of crop residue mulching .....	6
Adaptation of green manure legumes to adverse conditions in rice lowlands .....	6
Describing the root system of <i>Andropogon gayanus</i> , <i>Vigna unguiculata</i> and <i>Stylosanthes hamata</i> in the Sudan-Sahel zone .....	7
ANNOUNCEMENTS .....	8

umes implicated in one or more of these deleterious effects were *Centrosema pubescens*, three *Desmodium* species, *Lablab purpureus*, at least two *Stylosanthes* species, up to three *Trifolium* species and *Vigna unguiculata* forage. Skerman *et al.* (1988) linked the low palatability and intake of *Desmodium* species to the presence of tannins in the forage. However, an association between reduced palatability and the occurrence of secondary compounds remains to be established for the other pasture species cited above. Among the browse species of legumes the toxicity of *Leucaena leucocephala* is well recognized and characterized (Jones, 1994), but utilization of this legume is now being thwarted by damage caused by the psyllid (*Heteropsylla cubana*). Consequently, fresh impetus is being given to the exploitation of alternative species of browse and pasture legume species such as: *Gliricidia*, *Calliandra*, *Albizia*, *Acacia*, *Indigofera* and *Canavalia*. These species are all endowed with anti-nutritional factors (D'Mello, 1992). Thus, *Acacia aneura* is toxic to sheep through its content of condensed tannins (Pritchard *et al.*, 1988) and *Albizia lebbek* has been reported to contain hydrolysable tannins which are also attributed with adverse effects (Kumar and Vaithyanathan, 1990). Skerman *et al.* (1988) stated that the leaves of *Gliricidia sepium* were toxic to horses but not to cattle and goats. Although many *Indigofera* species appear to be suitable for livestock feeding, all accessions of *Indigofera spicata* are acknowledged to be toxic (Aylward *et al.*, 1987) and there is evidence of relatively low *in vitro* digestion of neutral detergent fibre and of organic matter in *Indigofera hirsuta* (Brown and Pitman, 1991; Brown *et al.*, 1991). *Canavalia ensiformis* forage is an unsuitable supplement for bulls fed diets based on sugar-cane juice or whole sugar cane, due to low palatability of the legume (Hughes-Jones *et al.*, 1981a, b).

It will be clear from the foregoing account that many tropical forage legumes are endowed with potent negative factors. Although much still needs to be elucidated, particularly with regard to the components causing reduced palatability, the anti-nutritional factors implicated thus far include tannins, cyanogens, saponins, non-protein amino acids, phytohaemagglutinins (lectins), alkaloids and oxalic acid. Thus, although oxalate is widely distributed in leguminous browse plants such as *Calopogonium mucunoides*, *Erythrina variegata* and *Bauhinia thingii* (Aletor and Omodara, 1994), its anti-nutritional role in practical feeding requires evaluation. Similar comments apply to phenolic amines such as N-methyl- $\beta$ -phenethylamine and tyramine which occur in *Acacia* species and may impair reproductive function in animals (Forbes *et al.*, 1994). A number of forage legumes have been screened for soluble phenols (Jones *et al.*, 1995).

(Reprinted from CAB International, Tropical Legumes in animal nutrition, edited by J.P.F. D'Mello and C. Devendra, pages 95-97, © 1995, with kind permission from CAB International)

## References:

- Aletor, V.A. and Omodara, O.A. 1994. Studies on some leguminous browse plants, with particular reference to their proximate, mineral and some endogenous anti-nutritional constituents. *Animal Feed Science and Technology* 46, 343-348.
- Aylward, J. H., Court, R. D., Haydock, K. P., Strickland, R. W. and Hegarty, M. P., 1987. *Indigofera* species with agronomic potential in the tropics. Rat toxicity studies. *Australian Journal of Agricultural Research* 38, 177-186.
- Brown, W.F. and Pitman, W.D., 1991. Concentration and degradation of nitrogen and fibre fractions in selected tropical grasses and legumes. *Tropical Grasslands* 25, 305-312.
- Brown, W.F., Lai, Z.Q. and Pitman, W.D., 1991. In vitro fibre digestion: associative effects in tropical grass-legume mixtures. *Tropical Grasslands* 25, 297-304.
- D'Mello, J.P.F., 1992. Chemical constraints to the use of tropical legumes in animal nutrition. *Animal Feed Science and Technology* 38, 237-261.
- Forbes, T.D.A., Carpenter, B.B., Randel, R.D. and Tolleson, D.R., 1994. Effects of phenolic monoamines on release of luteinizing hormone stimulated by gonadotropin-releasing hormone and on plasma adrenocorticotrophic hormone, norepinephrine and cortisol concentrations in wethers. *Journal of Animal Science* 72, 464-469.
- Hughes-Jones, M., Encarnacion, C. and Preston, T.R., 1981a. Some dietary interactions of sugar cane juice and high protein supplements. *Tropical Animal Production* 6, 271-278.
- Hughes-Jones, M., Encarnacion, C., Done, F. and Preston, T.R., 1981b. The influence of forages on digestion parameters of a sugar cane diet. *Tropical Animal Production* 6, 279-283.
- Jones, B.A., Hatfield, R.D. and Muck, R.E., 1995. Screening legume forages for soluble phenols, polyphenol oxidase and extract browning. *Journal of the Science of Food and Agriculture* 67, 109-112.
- Jones, R.M., 1994. The role of *Leucaena* in improving the productivity of grazing cattle. In: Gutteridge, R.C. and Shelton, H.M. (eds) *Forage Tree Legumes in Tropical Agriculture*. CAB International, Wallingford, pp. 232-244.
- Kumar, R. and Vaithyanathan, S., 1990. Occurrence, nutritional significance and effect on animal productivity of tannins in tree leaves. *Animal Feed Science and Technology* 30, 21-38.
- Pritchard, D.A., Stocks, D.C., O'Sullivan, B.M., Martin, P.R., Hurwood, I.S. and O'Rourke, P.K., 1988. The effect of polyethylene glycol (PEG) on wool growth and live weight of sheep consuming a mulga (*Acacia aneura*) diet. *Proceedings of Australian Society of Animal Production* 17, 290-293.
- Skerman, P.J., Cameron, D. G. and Riveros, F., 1988. *Tropical Forage Legumes*. Food and Agriculture Organization of the United Nations, Rome.
- I know the protein content of a dry forage. How do I calculate what it would be when I feed it green**  
 In: ECHO Development Notes issue 66 Edited by Martin Price, 1999, p. 3-4  
 Ivan Barineau and Daniel Sonke  
 Address: ECHO, 17391 Durand Rd, North Ft. Myers, FL 33917, USA.  
 Tel: (941) 543-3246, Fax: (941) 543-5317, E-mail:  
[echo@echonet.org](mailto:echo@echonet.org) or [dsonke@echonet.org](mailto:dsonke@echonet.org)

Mark Hare in Nicaragua was trying to determine how much protein was being produced in a given area of land with a given forage. He found the protein content for the forages on a dry weight basis in some books, but green material is what farmers feed to the animals.

ECHO turned to Dr. Ivan Barineau, a veterinarian with Christian Veterinary Mission, for the following answer to Mark's questions.

"Yes, there is a direct mathematical relationship between the protein content of a forage plant expressed as green vs. dry. In practical terms, one (the researcher or the farmer) might be interested in the amount of protein contained in a plant as (1) pasture or green chop or (2) ensiled or (3) dried into hay or (4) other. Nutritional analysis is often available in books or journals. The protein content is calculated for the parts of the plant that are most often used for feed. It is expressed as the percent protein in a plant that has been dried to essentially 0% moisture.

"Sometimes the analysis is based on the wet plant material 'as fed.' This might be (1) 'pasture' or 'green chop' or 'fresh' (2) air dried, i.e. hay or (3) ensiled.

"100% dry (0% moisture) is used as a way to directly relate protein contents between species. For example, on a dry weight basis the protein content of *Cajanus cajan*, aerial part, fresh midbloom is 38.3% and *Gliricidia sepium nicaraguan*, aerial part, fresh midbloom is 19.9%. One can not use these percentages to compare the protein content (or other nutrient content) of these two forage species if they are fed fresh because the difference may be partially due to natural differences in the amount of water in the plant. For example fresh *C. cajan* contains 63.5% water while *G. sepium* contains 73.7% water. However, comparisons could be made between different forms (e.g. fresh vs. hay) of the same plant.

"So to convert values between fresh, hay, ensiled, etc. forms of a grass, one needs to know the percent moisture. This is not difficult to ascertain. It usually has been worked out already and can be found in publications dealing with the nutrition content of forages."

"If you can not readily locate the value you can determine it yourself with a scale and sunshine. Weigh the fresh sample, then air dry it until it reaches a steady weight. This usually requires 1-3 days, depending on humidity and stem size. This 'air dried' form of the plant averages 90% dry matter or 10% moisture. In rainy season where drying might have to be done under shelter the 'air dry' moisture might be closer to 15-20%. Use 90% as your average under all but the rainiest conditions for 'air dry' value."

"However, for estimating use the following formula:  
Known protein % ÷ Known DM % = X ÷ known DM %  
(Dry matter = DM; Unknown protein % = X)

"Any form of the plant will do as long as the numerator and denominator are relative to the same form.

"For example, if we wish to know the protein content of *C. cajan* hay (90% DM) when we only know the percentage for, 'as fed' (fresh) or 100% dry. Use the value for 'as fed' (26.3% DM, 5.2% protein) and plug them into the formula.

$$5.2 \div 26.3 = X \div 90$$

$$X = \text{protein \% of hay @ 90\% DM}$$

$$26.3X = (5.2)(90); X = 17.8\% \text{ protein}$$

"We could have used the value from the 'dry' column just as well."

Excerpt from ECHO Development Notes issue 66 Edited by Martin Price, 1999 and Reprinted with kind permission from ECHO.

### **Mucuna in farming systems in northern Benin: Approaches and management alternatives**

Jonas A. Djenontin, Agro-zootechicien

Moutaharou Amidou, Agronome

Address: CRA-NORD/ INRAB, Ina, B.P. 03 N'Dali, République du Bénin E-mail s/c: [dg4@bow.intnet.bj](mailto:dg4@bow.intnet.bj)

Mucuna was introduced into farming systems in northern Benin almost a decade ago. In addition to its primary role as a suppressant of speargrass (*Imperata cylindrica*), farmers have also found that it regenerates soil fertility and produces fodder. However, the spread of mucuna is hampered by management related constraints. Indeed, farmers in northern Benin find the hoe and the plough quite unhandy for the incorporation of mucuna biomass into the soil. Worse still, the scarcity of manpower late in the wet season, as a result of the harvesting of cotton and food crops, does not allow for the burial of the biomass of mucuna which is left in the field at the mercy of roaming animals and bushfire.

The Research & Development team of the National Agricultural Research Institute of Benin (INRAB) is carrying out a collaborative experiment with the farmers in northern Benin in order to cut down on labor and devise appropriate tools and technologies to ease the incorporation of mucuna residues and protect mucuna's rotation against bushfire.

Mucuna is introduced into the cropping system through a rotation system including mucuna in short-term fallow. Thus, mucuna adds to the proportion of legumes in the farm and contributes to the diversification of the cropping system and to soil fertility management.

Mucuna as a rotation component is also one of the avenues for crop and livestock integration. It produces fodder for work oxen and small ruminants during the wet season. Stored mucuna haulms added to food crop and cereal residues provide the supplementary feedstuffs needed by work oxen during the dry season.

In order to achieve those newly set production objectives and to facilitate the management of mucuna in accordance

with the cropping calendar, farmers sow mucuna in June and reap it with machete in October–November. After the harvesting of the green fodder or the haulms of mucuna (about 67% of total biomass output), the remaining residues are ploughed into the soil at the end of the rainy season in October–November. Buried mucuna residues contribute to the improvement of soil fertility and 10–30% increase in the production of cotton and maize.

### Performance of *Stylosanthes hamata* var. *Verano*

H. Breman<sup>1</sup>, D. Coulibaly<sup>2</sup> and Y. Coulibaly<sup>2</sup>

<sup>1</sup> AB-DLO, B.P. 14, 6700 AA Wageningen, les Pays-Bas

<sup>2</sup> IER, B.P. 258, Bamako, République du Mali

In the PSS-region (Northern Sudan Savannah and Southern Sahel), *Verano* behaves as an annual crop. However, south of the region, a fraction of *Verano*'s population could be biennial in years of regular rains and on deep soils. The absence of fierce competition is an advantage to the crop. Thus, the year following establishment is often considered as the most productive year.

Just like for annual crops, performance in terms of germination and seed production determines particularly the crop's chances to survive and to make a sizeable contribution to the production system. *Verano* germinates very much like *Zornia glochidiata*, a leguminous crop with good survival ability but whose part in fodder production is significant only when conditions are not favourable for competitor crops; e.g. when run-off is stepped up by overgrazing on loamy-sand or sandy-loam soils. In such condition, absolute production is low. *Verano* has even slimmer chances in the study area. The reasons being i) In all likelihood, its plantlets are slightly more susceptible to drought; ii) Its ability to compete is lower during vegetative growth; iii) Its growth cycle is much longer than the 20–40 days of *Zornia* (Breman *et al.*, 1991). In fact, the growth period should cover at least 60 (De Leeuw, 1994) or 90 days (Mohamed-Saleem & De Leeuw, 1994). *Verano* thus exhibits a low seed production capacity in the conditions prevailing in the region. Such environment is highly adverse to *Stylosanthes hamata* and other accompanying perennial crops.

*Verano* enjoys two very distinct advantages: limited palatability during the rainy season and deep roots for continuous growth early in the dry season. The latter characteristics confer more resistance to *Verano* within the fodder bank exploited from December through January. But the usefulness of such property is limited to only a few years in the PSS-region; there are too many fodder banks in which the annual herbaceous stratum does not allow for the formation of a water stock at a depth of less than 2 m. The advantage runs parallel to two disadvantages namely the risk for annual production shortfall due to dry season rains and for heavy nitrogen dilution. *Zornia* contains 13–28 g kg<sup>-1</sup> of N by the end of the cycle (Breman & De Ridder, 1991), compared to 10–15 g for *Verano*. Biennial plants account for the lowest value recorded for *Verano*. So, the late exploitation required goes

hand in hand with a relatively limited stimulation of animal production. As a general rule, high production figures at a given rainfall, correlate with a heavy dilution of nutrients. The potentially very long cycle of *Verano*, that is 300 days (Mohamed-Saleem & De Leeuw, 1994) results in loss of quality. It is not easy to raise animals on *Verano* and *Stylosanthes hamata* in areas where it is comparatively easy to maintain the plant (Little & Agyemang, 1994).

Excerpt from the reports of Projet Production Soudano-Sahélienne (PSS) no. 17: Amélioration de parcours et production animale; le rôle des légumineuses en Afrique de l'Ouest. Wageningen, 1995, pp. 46–47

### References:

- Breman, H. & J.M. Krul, 1991 a. La pluviosité et la production de fourrage sur les pâturages naturels. In: F.W.T. Penning de Vries & M.A. Djitéye (eds.), La productivité des pâturages sahéliens. Une étude des sols, des végétations et de l'exploitation de cette ressource naturelle. Agric. Res. Rep. 918. Pudoc, Wageningen. p. 304–321.
- Breman, H. & N. de Ridder, 1993. Un manuel pour Evaluation et le suivi des pâturages des pays sahéliens. Gaston, A., M. Kernick & H.N. Le Houérou (Eds), Actes du quatrième congrès international des terres de parcours. Volume 2-Communications, pp. 971–974, CIRAD, Montpellier.
- Leeuw, P.N. de, 1994. Stylo as forage and fallow: Synthesis and review. In: P.N. de Leeuw, M.A. Mohamed-Saleem & A.M. Nyamu (eds). *Stylosanthes* as a forage and fallow crop. Proceedings of the Regional Workshop on the Use of *Stylosanthes* in West Africa held in Kaduna, Nigeria, 26–31 October 1992. International Livestock Centre for Africa, Addis Ababa, p. 325–334.
- Little, D.A. & K. Agyemang, 1994. An assessment of stylo as a source of supplementary feeding. In: P.N. de Leeuw, M.A. Mohamed-Saleem & A.M. Nyamu (eds). *Stylosanthes* as a forage and fallow crop. Proceedings of the Regional Workshop on the Use of *Stylosanthes* in West Africa held in Kaduna, Nigeria, 26–31 October 1992. International Livestock Centre for Africa, Addis Ababa, p. 147–154.
- Mohamed-Saleem, M.A. & P.N. de Leeuw, 1994. Stylo-based pastures for livestock production. In: P.N. de Leeuw, M.A. Mohamed-Saleem & A.M. Nyamu (eds). *Stylosanthes* as a forage and fallow crop. Proceedings of the Regional Workshop on the Use of *Stylosanthes* in West Africa held in Kaduna, Nigeria, 26–31 October 1992. International Livestock Centre for Africa, Addis Ababa, p. 139–145.

## OTHER REPORTS ON COVER CROPS

### Characterization of the seed proteins of velvet bean (*Mucuna pruriens*) from Nigeria

Jesse Machuka

Address: International Institute of Tropical Agriculture, c/o LW Lambourn & Company LTD, Carolyn House, 26 Dingwall Road, Croydon CR9 3EE UK. E-mail: [j.machuka@cgiar.org](mailto:j.machuka@cgiar.org)

Tel.: + 44-2342-241-2626; fax+ 44-2342-241-222 1

This paper reports the preliminary characterization of seed protein fractions from seven varieties of velvet beans (*Mucuna pruriens*) grown in Nigeria, using sodium dodecyl sulphate-polyacrylamide gel electrophoresis (SDS-PAGE). Three of the most abundant polypeptides, with approximate Mr of 23, 26 and 30 kDa, respectively, were further separated by preparative native-PAGE. N-terminal sequencing

revealed the presence of the consensus sequence DDREPV-DT-PL that is also present in the soybean Kunitz-type trypsin inhibitor. The albumin fraction was also shown to contain both trypsin and chymotrypsin inhibitors through enzyme inhibitor assays. Western analysis using antibodies, raised against a representative, 23 kDa polypeptide, indicated that this protein species accumulates exclusively during seed development, suggesting a role in seed storage. Haemagglutination assays using rabbit erythrocytes failed to detect the presence of lectins. The results are discussed within the context of the role of lectins and protease inhibitors in storage and plant defence. The findings are also relevant in view of the toxic and antimetabolic effects of these proteins, which determine the acceptability and adoption of velvet beans as animal and human feed.

(Reprinted from Food Chemistry, Volume 68, Jesse Machuka, Characterization of the seed proteins of velvet bean (*Mucuna pruriens*) from Nigeria, pages 421-427, © 2000, with permission from Elsevier Science )

### Studies on chemical composition and antinutritional factors in three germplasm seed materials of the tribal pulse, *Mucuna pruriens* (L.) DC

R. Mary Josephine and K. Janardhanan  
Address: Seed Physiology Laboratory, Department of Botany, Bharathiar University, Coimbatore - 641 046, India

Three germplasm seed materials of the Indian tribal pulse, *Mucuna pruriens*, collected from different agroclimatic regions [Begur Reserve Forest and Silent Valley in Kerala State and Mothimahal Campus, Lucknow (Uttar Pradesh)] were analysed for proximate composition, seed protein fractions, amino acid composition, minerals and antinutritional factors. All three germplasm seed materials of *M. pruriens* analysed contained higher contents of crude protein and crude lipid when compared with most of the commonly consumed pulses and other species of *Mucuna*. Albumin and globulin fractions constituted the major bulk of seed proteins in all three germplasms. Profiles of amino acids revealed that the seed proteins contained relatively higher levels of all the essential amino acids except sulpho-amino acids in all the three germplasms of *M. pruriens* and threonine in the germplasms of Silent Valley and Lucknow when compared with the WHO requirement pattern. In addition, the seed proteins of Lucknow germplasm were found to be limiting in isoleucine + leucine also. All three samples of *M. pruriens* were rich in minerals such as K, Mg and P. The Begur Reserve Forest germplasm was also rich in Fe. Except for L-DOPA, all antinutritional factors detected/quantified were heat-labile and hence could be eliminated by cooking. The albumins of Lucknow germplasm alone exhibited weak agglutination with erythrocytes from 'O' blood group. In all three samples, globulins showed weak agglutination with erythrocytes without any specificity.

(Reprinted from Food Chemistry, Volume 43, R. Mary Josephine and K. Janardhanan, Studies on chemical composition and antinutritional factors in three germplasm seed materials of the tribal pulse, *Mucuna pruriens* (L.) DC, pages 13-18, © 1991, with permission from Elsevier Science )

### Farmers' perceptions and the dynamics of adoption of a resource management technology: the case of *Mucuna* in southern Benin, West Africa

Albert N. Honlonkou<sup>1</sup>, Victor M. Manyong<sup>2\*</sup>, and N'guessan Tchetché<sup>1</sup>

<sup>1</sup> Centre Ivoirien de Recherches Economiques et Sociales (CIRES), Université de Cocody, 08 B.P. 1295 Abidjan 08, Côte d'Ivoire

<sup>2</sup> International Institute of Tropical Agriculture (IITA), Oyo-Road, PMB 5320 Ibadan, Nigeria

\*Corresponding author

E-mail: [v.manyong@cgiar.org](mailto:v.manyong@cgiar.org)

Concern about the increasing degradation of natural resources in developing-country agriculture has led to the development of improved systems that make use of biological processes to promote production in a sustainable manner. The paper uses a case study on the adoption of *Mucuna* (*Mucuna pruriens* var. *utilis*) to examine the farmers' perceptions and dynamics in the adoption of such improved systems. Small-scale farmers ranked *Mucuna* fallow more highly than chemical fertilizers because of its weedicide effect, long-term improvement of soil fertility, low cost, and ease of availability at the village level. The grass roots extension organizations played a significant role in the dissemination of *Mucuna*. The removal of incentives to adopt did not adversely affect the trends in the spread of the technology. However, farmers consider insecure land tenure a constraint to adoption for (even) this non-perennial species.

(Reprinted from International Forestry Review, Volume 1(4), Albert N. Honlonkou, Victor M. Manyong, and N'guessan Tchetché, Farmers' perceptions and the dynamics of adoption of a resource management technology: the case of *Mucuna* in southern Benin, West Africa, pages 228-235, © 1999, with permission International Forestry Review)

### Management of cogongrass (*Imperata cylindrica*) with velvetbean (*Mucuna pruriens* var. *utilis*) and herbicides

Udensi E. Udensi, I. Okezie Akobundu, Albert O. Ayeni, and David Chikoye<sup>1</sup>

<sup>1</sup> Corresponding author, Weed scientist, International Institute of Tropical Agriculture, PMB 5320, Oyo Road, Ibadan, Nigeria,

E-mail: [d.chikoye@cgiar.org](mailto:d.chikoye@cgiar.org)

Field experiments were conducted in 1992 to 1993 and in 1995 to 1996 in Ibadan, Nigeria, to assess the effect of velvetbean and herbicides on maize (corn) and cogongrass growth and to assess regrowth of the weed 1 yr after treatment. In 1992 and 1995 cover cropping with velvetbean and imazapyr and glyphosate application reduced cogongrass density as much as the handweeded control. The smothering effect of velvetbean was equivalent to that of glyphosate at 1.8 kg/ha but was less than imazapyr even at the lowest rate of 0.5 kg/ha. Addition of adjuvant did not improve the efficacy of either herbicide. Maize grain yield was higher in velvetbean plots than in fallow plots dominated by cogongrass. Velvetbean and herbicide effects on cogongrass 1 yr later (1993 and 1996) followed a similar trend as observed in the year of application. Annual weed density was highest in glyphosate plots, followed by imazapyr, and least

in plots previously seeded to velvetbean. Maize grain yield was higher in herbicide plots (average yield of 3,170 and 1,920 kg/ha in 1993 and 1996, respectively) than in velvetbean plots (2,800 to 1,180 kg/ha in 1993 and 1996, respectively) and handweeded plots (2,890 and 723 kg/ha in 1993 and 1996, respectively). In 1996 the lowest maize yield was in handweeded plots without velvetbean, suggesting that weeding four times suppressed cogongrass density and biomass, but was not sufficient to minimize the subsequent competition from annual weeds. Uncontrolled cogongrass reduced maize yield to zero. These studies suggest that planting velvetbean for cogongrass control may be a better alternative for farmers without the resources to purchase herbicides.

(Reprinted from Weed Technology, Volume 13, Udensi E. Udensi, I. Okezie Akobundu, Albert O. Ayeni, and David Chikoye, Management of cogongrass (*Imperata cylindrica*) with velvetbean (*Mucuna pruriens* var. *utilis*) and herbicides, pages 201-208, © 1999, with kind permission from Weed Science Society of America)

### The economics of soil conservation in developing countries: The case of crop residue mulching

Olaf C.A. Erenstein, 1999. Thesis. Wageningen . Wageningen University.  
Address: Westerhofseweg 21; 6707 GA Wageningen; The Netherlands.  
E-mail: [olaf\\_erenstein@usa.net](mailto:olaf_erenstein@usa.net)

The study contributes to the search for a methodology to assess soil conservation, particularly in developing countries. The study first assesses the economics of soil conservation in general - with special emphasis on the relationships between technology, economic analysis and policy implications. The quantification and valuation of soil erosion and soil conservation are highly controversial and present considerable analytical challenges that have been tackled in varying ways. By implication, government intervention is controversial too - and has typically been unsuccessful. This has direct implications for both the development of conservation technology and the implementation of conservation interventions.

The study subsequently assesses the economics of one particular technological conservation option: crop residue mulching (also known as conservation tillage). An analytical framework is developed to assess the socio-economics of the technology in developing countries. The technology assessment framework follows a stepwise expanding analysis along a three-tier hierarchy: crop production, the farm household and the institutional setting. This results in a private and a social assessment of the technology, and the formulation of corresponding policy implications. The framework is applied in *ex ante*, *ex post* and partial analyses of crop residue mulching in different settings in Mexico and Central America. Conclusions are drawn regarding the technology assessment framework and crop residue mulching.

The thesis has also been published by Backhuys publishers in the Mansholt series and can be ordered through them. For ordering details see: <http://www.sls.wau.nl/MI/Studies/stud14.htm>

### Adaptation of green manure legumes to adverse conditions in rice lowlands

M. Becker and J.K. Ladha  
Addresses:  
M. Becker, University of Bonn, Germany,  
E-mail: [mathias.becker@uni-bonn.de](mailto:mathias.becker@uni-bonn.de)  
J.K. Ladha, International Rice Research Institute (IRRI), PO Box 933, Manila, Philippines.

Poor adoption of sustainable pre-rice green manure technology by lowland farmers is frequently associated with unreliable legume performance under adverse environmental conditions such as marginal soils, short photoperiod, and unfavorable hydrology. A series of field and microplot experiments were conducted at the International Rice Research Institute (IRRI) in 1991 and 1992 to screen and evaluate 12 promising flood-tolerant legumes for adaptation (N accumulation and biological N<sub>2</sub> fixation) to a range of environmental stresses, frequently encountered in rice lowlands. Legumes belonging to the genera *Sesbania* and *Aeschynomene* were grown for 8 weeks at 10x10 cm spacing: (1) in a fertile control soil and in four marginally productive irrigated lowland rice soils (sandy Entisol, P-deficient Inceptisol, acid Ultisol, and saline Mollisol); (2) during short- (11.7 h) and long-day (12.3 h) seasons in a favorable irrigated lowland soil; and (3) in an aerobic soil (drought-prone rain-fed lowland) and a deep-flood-prone lowland soil (1 week seedling submergence). A large variability in N accumulation was observed among legume species and across different environments, ranging from less than 1 to over 70 mg N plant<sup>-1</sup>. The nitrogen derived from the atmosphere (Nd<sub>fa</sub>) accounted on average for 82% of total N accumulation. *Sesbania virgata* was least affected by unfavorable soil conditions but its Nd<sub>fa</sub> was the lowest among the tested species (less than 60%). Stem nodule formation did not convey a significant advantage to legumes grown under adverse soil conditions. However, flooding reduced N<sub>2</sub> fixation less in stem-nodulating than in solely root-nodulating species. Most species drastically reduced N accumulation under short-day conditions. *Aeschynomene afraspera* and *S. speciosa* were least affected by photoperiod. The considerable genetic variability in the germplasm screened allows the selection of potentially appropriate legumes to most conditions studied, thus increasing N accumulation in green manures.

(Reprinted from Biology and Fertility of Soils, Volume 23, M. Becker and J.K. Ladha, Adaptation of green manure legumes to adverse conditions in rice lowlands, pages 243-248, © 1996, with permission from Springer-Verlag)

### Describing the root system of *Andropogon gayanus*, *Vigna unguiculata* and *Stylosanthes hamata* in the Sudan-Sahel zone

J.J.R. Groot<sup>1</sup>, D. D. Koné<sup>2</sup> and N. Kamissoko<sup>2</sup>.  
<sup>1</sup> AB-DLO, B.P. 14, 6700 AA Wageningen, les Pays-Bas  
<sup>2</sup> Institut d'Economie Rurale (IER), B.P. 258, Bamako, République du Mali

The root systems of the fodder species *Andropogon gayanus*, *Stylosanthes hamata* and *Vigna unguiculata* (cowpea) were studied at the end of the rainy season of 1992. The study was executed at Cinzana Agronomic Research Station (average rainfall 700 mm yr<sup>-1</sup>) and at N'Tarla Agronomic Research Station (average rainfall 900 mm yr<sup>-1</sup>). Root samples were taken according to the pinboard monolith method.

The results of the root biomass sampling for *Andropogon gayanus* were not quite satisfactory, caused by the large spatial variability in plant distribution and plant size. It was concluded that the reliability of the sampling method increases with increasing plant density and crop homogeneity.

The age of the *Andropogon gayanus* population seemed to have no effect on root production; in N'Tarla the population installed since 1951 produced 4 t ha<sup>-1</sup>, while the population in Cinzana installed in 1991 produced 5 t ha<sup>-1</sup>. However, above ground productions for N'Tarla and Cinzana were 12 t ha<sup>-1</sup> and 8 t ha<sup>-1</sup>, respectively. It may well be possible that investments in the root system are more important during the installation of a young population than for a well-established population. 90 % of the *Andropogon gayanus* root biomass was concentrated in the upper 60 cm of the soil profile, and maximum rooting depth in N'Tarla was 180 cm; in Cinzana the maximum rooting depth of 120 cm was the result of a hard-pan at this depth. Generally, a negative exponential decrease in root biomass was observed, but root length density (cm root cm<sup>-3</sup> soil) decreased to a lesser extent, indicating that specific root length (root length (m) per gram root weight) increased with depth (roots have smaller diameters in the deeper layers).

Root biomass production of *Vigna unguiculata* was estimated at 1188 kg ha<sup>-1</sup> without application of phosphorous (average of two repetitions) and at 2922 kg ha<sup>-1</sup> in case of non-limitative phosphorous supply. However, there was little effect on the above ground production: 4200 kg ha<sup>-1</sup> without application and 4900 kg ha<sup>-1</sup> with application of phosphorous. A change in specific root length with depth could not be observed for *Vigna unguiculata*.

Hardly any response to phosphorous application in root biomass of the semi-perennial leguminous *Stylosanthes* ha<sup>-1</sup> was observed: 3596 kg ha<sup>-1</sup> without application and 4161 kg ha<sup>-1</sup> with phosphorous application. Above ground productions were 8360 kg ha<sup>-1</sup> and 10860 kg ha<sup>-1</sup> for treatments without and with phosphorous application, respectively. The distribution of root biomass with depth was more homogeneous than for *Andropogon gayanus* and *Vigna unguiculata*, and root densities were high throughout the whole soil profile. Specific root length increased from 35 m g<sup>-1</sup> for the 0-10 cm layer to 100 m g<sup>-1</sup> for the 130-140 cm layer. The presence of high root length densities throughout the whole profile allows an efficient use of water and nutrients, and is especially important to satisfy the phosphorous requirement of the crop.

The majority of the root production at the end of the growing season can be considered as an input of organic matter.

The root biomass and nutrient contents as measured allow to calculate the rest-effects of nitrogen fixation; for *Vigna unguiculata* the amount of nitrogen supplied by the root system was approximately 40 kg ha<sup>-1</sup> and for *Stylosanthes hamata* in the order of 60 kg ha<sup>-1</sup>.

Excerpt from the reports of Projet Production Soudano-Sahélienne (PSS) no. 8: Description du système racinaire de l'*Andropogon gayanus*, du *Vigna unguiculata* et du *Stylosanthes hamata* en zone soudano-sahélienne. Wageningen, 1995.

## ANNOUNCEMENTS

### Mucuna as food crop?

With the support of the Rockefeller Foundation, CIDICCO will be hosting the seminar "Food and Feed from Mucuna; Current Uses, Limitations and the Way Forward" from 26–29 April. Around 20 people from several disciplines and countries, who have directly or indirectly worked with Mucuna will meet in Tegucigalpa (Honduras).

During 1999 a working group of several colleagues from different institutions throughout the world carried out a project we nicknamed "The Exploration". One of the emerging issues was precisely the need to clarify once and for all the viability of using Mucuna as food and feed.

For more information, please contact:

Milton Flores  
CIDICCO Director  
Apartado Postal 4443  
Tegucigalpa MDC, Honduras C.A.  
Tel: (504) 232-3850, 239-5851  
Fax: (504) 239-5859  
E-mail: [cidicco@sdnhon.org.hn](mailto:cidicco@sdnhon.org.hn)

### Regional cover crops workshop

In October 1999, a regional cover crops workshop was held in Cotonou, Benin, to update collaborators on progress since the 1996 regional meeting. The workshop was co-sponsored by CIEPCA, IITA, CIIFAD/MOIST (Cornell University) and CCropNet. Participants were trained in the use of LEXSYS and in the recognition of diseases on cover crops. They were also exposed to Internet technology. Thirty-five papers were presented in the areas of:

- Cover crops benefits
- Participatory systems development
- Cover crops germplasm
- Country and network reports

Names of participants, titles of presentations, and recommendations of the meeting can be found at:

<http://www.cgiar.org/spipm/news/ccropmtg/ccrwkmen.html>

### CCropNet Web Site

In the last issue we announced the creation of a network of cover crops workers called CCropNet. We are happy to announce that they now have a web site at:

<http://www.cgiar.org/spipm/ccropnet/index.htm>

The web site describes in more detail the aims of the networks, their methods and research sites, as well as some photographs of potential new cover crops.

### Pueraria seeds for sale

In the Democratic Republic of Congo, a locally based seed company harvests and sells 2 to 3 tonnes of *Pueraria sp.* seeds every year. Harvesting takes place between August and September.

For further information, contact:

Jean-Claude Troupin  
c/o SDE (Société pour le Développement et l'Expansion d'Entreprises)  
66 Rue de Livourne boîte 6  
1000 Bruxelles  
Belgique  
Tel:00 32 2 538 07 90  
Fax:00 32 2 538 19 73  
E-mail: [troupin@pophost.eunet.be](mailto:troupin@pophost.eunet.be)

#### Editorial Committee:

A.C. Etèka (CIEPCA Coordinator)  
R.J. Carsky (RCMD/ IITA)  
S.A. Tarawali (ILRI- IITA)  
P.M. Vernier (IITA/ CIRAD)  
T. Owoeye (ISAT/ IITA)

**Translation:** O. Hounvou and C. Moudachirou

**Publisher:** CIEPCA

**Sponsors:** Rockefeller Foundation, International Institute of Tropical Agriculture

#### Coordinator address:

CIEPCA Coordinator, IITA 08 B.P. 0932 Tri Postal, Cotonou Bénin Tel: 229-35 01 88

**Fax:** 229-35 05 56

**E-mail:** [ciepca@cgiar.org](mailto:ciepca@cgiar.org)