

Sustainable Forage Production Strategies for Small Scale Livestock Production in Zimbabwe

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Abstract – This paper seeks to review current forage production strategies, constraints to and opportunities for small-scale livestock production in Zimbabwe.

Crops and livestock form an integral component in providing food for the human population in rural areas of Zimbabwe. This has necessitated re-orientation in developing technical packages that integrate the two production systems. Food crops are produced for subsistence, livestock are raised to provide mainly draught power for crop cultivation, and other secondary outputs such as milk, meat, hides and manure.

Existing forage production practices in the small scale farming areas of Zimbabwe depends on availability of resources such as land, capital, inputs and labour. Most farmers in these farming areas give priority to crop production and not much land is left fallow for forage production. Feed resources available for livestock are maize, groundnuts, soyabeans and cowpea stover. Forages produced for livestock are include napier grass, legume siratro and other indigenous species.

Production of the forages also depends on management practices, that is, crop establishment, nutrient supply, weed and pest control, seed production, forage conservation and utilization. A major point for the cultivation of forages lies in their potential to provide improved quantity and quality feed to livestock and legumes improving soil fertility.

Most research work on forage production has been conducted at research stations and of late efforts are being made to conduct them on-farm. Results from have been made to gather dust in office drawers instead of reaching the intended users. There is low adoption of forage production technology in the small scale farming sector as evidenced by poor management practices and low forage yields. A deeper understanding of the farming systems in these areas, farmers' perceptions of forages and constraints limiting improved forage production is key to all research work. This entails identifying the clients of research, systems of disseminating research results to the appropriate beneficiaries and how research results are utilized. Strategies on utilization of research results involve institutional support, farmer training, farmer-to-farmer extension, farmer field schools, farmer participation in research work, identifying gender roles, costs involved and appropriateness of technologies under which the small scale farmers operate.

Achieving agricultural sustainability in forage production for livestock is also a function of the social, economic and agro-ecological environment in which farmers are exposed to. Growth in forage production is inevitable and can reduce food insecurity through availability of livestock feed and soil fertility improvement while increasing farm incomes, employment and general farmer livelihood.

The forage production strategies are also supported by the five I² for success and they include innovation (research and extension systems), infrastructure (road and transport

systems), inputs (farm inputs, credit, irrigation water), institutions (markets and support services) and incentives (policies and trade).

Keywords – forage production, livestock, small scale, Zimbabwe

I. INTRODUCTION

Zimbabwe's economy is agro-based and 76% of the total population depends on it for their livelihood. Agriculture contributes 18% to the GDP, 40% of export earnings and 60% to the manufacturing sector, and employs 26% of the workforce [Commercial Farmers' Union (C.F.U.), 2000]. The country is proud of producing a variety of products from agriculture, which include food crops, horticultural crops, forestry and livestock.

Livestock plays an important role in Zimbabwe. It produces meat, milk, is considered a source of wealth and generates employment. Maximum production could be achieved only if animals are supplied with sufficient quantities of raw materials required for the synthesis of these products.

A report by Food and Agriculture Organisation of the United Nations (FAO, 2007) indicates that crop production and livestock numbers have also decreased during the period 1999 to 2006. Cattle decreased by 16.7% while small stock reduced by 1.4%. Records from the Central Statistics Office (CSO) in Zimbabwe indicate a similar trend for both crops and livestock over the same period. This can be attributed to the Land Reform Program which commenced in the year 2000, reduced crop yields, reduced livestock grazing and severe droughts experienced in 1981-82, 1983, 1986-87 and 1991-92, lack of farming inputs and limited knowledge on appropriate farming practices by the new breed of farmers and the small-scale farmers.

Although much research has been carried out on forage production and is well documented, there is still need for farmers to adopt the research results and practices in order to improve livestock production. The low adoption rate is evidenced by the low production levels and limited knowledge of some of the research practices done.

Most of the small-scale farmers practice dry-land farming, that is, they rely on rainfall to produce forages for livestock feed. With the occurrence of extended mid-season droughts during the rainy season, this leads to crop failure, resulting in reduced livestock feed and subsequent deterioration of body condition of the animals.

Infrastructure and support systems need to be put in place to support production of raw materials even in this harsh economic climate. Small-scale farmers face difficulties in accessing inputs due to limited financial resources and lending institutions are not willing to offer credit to this group of farmers as it is viewed as high risk, with low repayment capacity and lack of collateral.

This paper seeks to review current strategies, research gap, constraints to and opportunities for forage production in the small-scale farming areas in Zimbabwe.

Sustainable forage production can be defined under the heading of sustainable agriculture. Defined as agricultural technologies and practices that maximise the productivity of the land whilst seeking to minimise damage both to valued natural assets (soils, water, air and biodiversity) and to human health (farmers and other rural people, and consumers). Sustainable strategies are regenerative and resource conserving technological plans that have a long-term positive effect but with the aid of immediate tactics or actions. Forage production will include both grasses and legumes.

II. FORAGE PRODUCTION STRATEGIES

2.1 Forage management practices

Appropriate forages

In Zimbabwe, most areas are suitable for the production of different species of forage grasses and legumes. The grasses include napier grass (*Pennisetum purpureum*) and legumes include siratro (*Macroptilium atropurpureum*). The fibrous roots of napier grass are good for soil erosion control. Kariuki (1998) has also found out that the cell wall content in Napier increases less prominently with age compared with other tropical grasses. The yield of the forage grasses range between 5 and 12 tonnes/hectare/year. This makes it suitable for small-scale farming areas where production resources are limited and cutting frequency is lengthened due to other farm activities. The choice of napier grass is also based on the fact that some farmers have already adopted and are producing the grasses for their dairy cows.

The production of legumes has benefits of soil improvement by nitrogen fixation and addition of organic matter in the soil, erosion, pest and disease control and landscape stability (Humphreys, 1994). For these to be realised, Ndlovu (1996) emphasised that the technology should fit well in the present farmer's environment.

The importance of forage legumes in increasing overall herbage production and feeding value of pasture systems have been well demonstrated (Abate *et al*, 1992). Recommendation for inclusion in livestock rations and the knowledge of the growth of each species at a particular site is important and a large number of legume species have been established successfully in Zimbabwe (Mupangwa, 1996). Mhere *et al*, (2002) also mention that there are forage grasses (pennisetums and forage sorghum) and legumes

(dolichos lablab and cowpeas) that are suited to drier areas of Zimbabwe. Therefore, there is need to assess their suitability for ruminant production systems especially with respect to the efficient utilisation of dietary protein. This seems to be the important aspect because D'Mello and Devendra (1995) say that the leguminous nutritive value is only important after the performance of the legume is known. Several studies have demonstrated the beneficial effects of incorporating forage legumes in sustaining crop-livestock production systems and the environment. Research should also focus on drought resistant species as occurrences of droughts are becoming more frequent. This will go a long way in availing livestock feed, reduce land degradation and improve soil fertility.

Establishment

The main strategy for the establishment of forages is to ensure that the crop is established at the beginning of the wet season although Humphreys (1987) and Skerman and Riveros (1990) stressed the importance of ensuring adequate moisture for seedling establishment in relation to sowing depth. Mureithi and Thorpe, 1996 noted that although fodder yields of Napier when intercropped with legumes were not affected, Innis, 1997 and Muchadeyi, 1998 found out that growing companion crops affects the performance of each of the crops grown such as cowpea and maize.

Overall, benefits from intercropping increase as the plants have more room (more light, water and sunlight per plant), very little extra hand labour is needed to intercrop, less insects, pests and weeds (Innis, 1997).

Skerman *et al*. (1988) estimated fixation of N at 84 kg/ha if rhizobia is effective. Establishment of the forages in rows and across the slope helps on management of the crop such as weed, erosion and pest control. This should fit in farming systems as small-scale farmers give priority to production of food crops and can only embark on forage production when there is uncultivated land and inputs are available. Growing of forages with companion crops are that land preparation for the crops is made once and saves on labour for weeding.

Nutrient supply

Sources of nutrient supply for forages available to small-scale farmers include fertilisers and manure, but they prefer using manure. However the danger of environmental pollution from using too much fertiliser should always be remembered although when manure is used alone, it cannot maintain soil fertility under continuous cropping (Bayer and Waters-Bayer, 1998). Deep, fertile loam soils produce the best growth although Crowder and Chheda (1982) say output of grasslands and grazing lands can be increased by application of fertilisers.

Therefore the use of fertilisers Nitrogen (N), Phosphorus (P), Potassium (K) is required especially on poor sandy soils. Humphreys (1987) highlights that companion crops involving forage grasses should be that sowing the grass does not affect yield of the main crop such as maize, as farmers will not take up the technology. In grass-legume

mixtures, care should be taken on selection of combinations, as one crop will outgrow the other.

Under Zimbabwean sands, it is generally recommended to apply 300-500 kg lime and 250-300 kg Single super phosphate (SSP)/ha/year to be incorporated at land preparation. For grasses, 30 kg N/ha has to be applied after establishment to boost growth and 60 kg N/ha after every cut. Because potash is removed at cutting, it has to be applied at about 100 kg MOP/ha after every two cuts.

Palmer et al (1994) found out that the use of fertiliser particularly in infertile soils, will improve the early growth and yield of some legumes species, but is less responsive to fertiliser than some other legumes and will often out yield other species on infertile soils.

In a general nutrient cycle, where organic matter plays a key role in the continuous supply of N to the pasture plants, it is important to appreciate that, at various stages of the cycle, there is not a clear-cut sequence of transformation but a number of alternatives.

Weed and pest control

Small-scale farmers can control weeds by the use of chemicals or by using hand hoes. Unfortunately the cost of chemicals is high and forage production does not warrant the use of such chemicals. Authors, Skerman and Riveros (1990), advise that thorough ploughing and crop rotation will reduce weed and pest population. Supply of adequate nutrients to the forage crops, ensures early growth and suppress weeds which in most cases harbour insects. Use of chemicals worsens the problem as weeds and pests build resistance, besides being not environmentally friendly.

The aphid infestation has been noted to increase when there is a dry spell during the growing season of some cowpea varieties (Muchadeyi *et al*, 2001). To overcome this, Innis (1997) recommends early planting so that plants establish to be able to survive an aphid attack during the dry spell, intercropping different crops such as cowpea and maize and interspacing plants of an immune species throughout the field in mono-cropped fields.

Seed Production

There is great variation in ability of forages to produce seed. Seeds of some forage grasses such as Napier are infertile (Kariuki, 1998), therefore are vegetatively propagated. Rhodes grass seed production is not uniform throughout the season (York and Nyamadzawo, 1990) and hand picking in cowpea (Skerman *et al.*, 1988) proves to be labour intensive. Mature pods of legumes such as siratro and cowpeas shatter and if not harvested on time, heavy seed losses will be incurred.

Forage seed harvesting need to coincide with periods when farmers have completed harvesting crops in the fields, as the technology will not be adopted.

Yield and quality

The strategy that could be available for small-scale farmers in Zimbabwe is on identifying the most appropriate

time to harvest forages so as to have improved yield and quality.

Manyawu and Mhere (2001), from trials done in Zimbabwe, found out that the most appropriate time to cut napier grass is at 6 weeks interval and this will enable about 4-5 cuts per season thus achieving yields are around 6-12 t DM/ha. When Rhodes grass is made into hay, the recommended practice in Zimbabwe is to cut at the start of flowering (about 7- 10%).

On legumes, Muchadeyi (1998) noted that siratro forage is best harvested before leaves fall off and stems become too thick and dry as palatability of the stems will be reduced (table 1).

Table 1: Dry matter digestibility (DMD) g/kg of cowpea in relation to time of maize/legume planting

Planting time	DMD g/kg
Same time with maize	526
Maize crop at 50 cm height	717
Maize crop at 100 cm height	630

Source: Muchadeyi (1998)

Forage Conservation

Strategies to improve the quality of hay produced, is by cutting at 10% flowering stage, rapid removal of moisture from cut herbage. Harvesting hay takes many nutrients from the land and if nutrients are not supplied in manure or fertilisers, intensive haymaking can threaten the sustainability of forage production.

Silage can be prepared out of Napier and Rhodes grass although authors say the later does not have the bulk. Unfortunately small-scale farmers do not have large pieces of land, also the yield, lack of equipment and effort involved does not warrant silage making.

Although silage from forages is gathering momentum among smallholder farmers in Zimbabwe, some aspects that make farmers not to adopt this technology are high costs of ensiling the material, limited available land and small animal units. To overcome this, Titterton et al. (2000) mention that forage grasses and legumes can be mixed and ensiled successfully in small bags with only manual chopping and compression. However, silage has been associated with a number of diseases such as high butyric acid content, high concentration of ammonia facilitates an excessive absorption of ammonia from the rumen, fungal and bacterial contamination

Forage utilisation

However grass hay is generally inadequate as a sole feed to supply the animal's nutrient requirements for maintenance. Feeding of grass hay alone, intake was observed to low but increases were noted with supplementation with legumes (Mupangwa et al., 2000). Literature says legumes contain anti-nutritional factors such as tannins, which limit their intake and digestibility, although in cowpea they are lower than other legumes (Baloyi et al, 2000).

2.2 Points to Consider on the Adoption of Forage Production

2.2.1 Dissemination strategies of forage production technology

Researcher-extension-farmer Linkages

The weak linkages between research and extension, which is aggravated by organisational set up, can be improved by the departments working in close consultation or being under one supervisor (Adams, 1982) as this will improve communication. This can be in the form of in-service training at vocational schools (van den Ban and Hawkins, 1996) or training for all partners, that is, researchers, extensionists and farmers (Caffarella, 1987) and participation also during the training. All possible forms of message dissemination are essential although the one that gives the best impact should be selected.

One way to overcome the problem of isolating researchers from practical farming outside the station fence is to have the research station and field extension service under one manager. Adams, 1982 explains that the two can benefit greatly from such integration, especially when an experienced agricultural scientist is in charge. He further mentions that extension services need research centre back up and its participation in programme planning and provision of support during implementation in order to ensure that the technology being offered is appropriate to the locality.

Ndlovu and Francis (1997) mention that the high integration of crops and livestock in small-scale farming systems in Zimbabwe needs deliverance of a complete package of forage improvement for a number of purposes such as legumes for animal feed, soil improvement, food, erosion control and fuel wood.

The different existing organizations that serve small-scale farming area should be able to assist the farmers through several strategies. There is need for improved institutional support (Hanyani-Mlambo *et al.*, 1998) for services such as farm visits by research and extension (Adams, 1982) and effective use of Training and Visit system (van den Ban and Hawkins, 19986) for the benefit of the farmers

2.2.2 Strategies on utilisation of research results

Training and farmer-to-farmer extension

A number of farmer Training Centres that offer forage production courses are available in Zimbabwe. In training, there is sharing of ideas, information, experiences and findings (Chambers, 1993). In training, participant farmers learn participatory skills and other aspects concerned with their needs. Therefore it is imperative that farmers are able to participate during the training sessions. Farmers are trained on technical aspects of forage production or how to participate in forage production research. This gives the farmer pride and eagerness to participate. The training sessions should include gender aspects as women are usually marginalized when training programs are organised.

Farmers can be trained to become trainers in forage production aspects. While professionals may support this process with technical information, methodological training and organisational capacity building, it is still primarily a farmers' activity based on and in their own culture (Scarborough *et al.*, 1997). Methodologies such as *campesino-a-campesino* can be organised and implemented on a project level.

Farmer field schools

Main idea is to facilitate small-scale farmers to become experts in developing technologies and managerial practices to solve their specific problems within the agro-ecological context of their own farm. It involves farmers in learning and discovering for themselves relationships between crops, pests, predators, soil and water in the fields. The main strategies are to begin a group learning process among farmers through Integrated Pest Management (IPM) field schools and continue to support and monitor group activities and experimentation over several growing seasons, and to link these field school groups together in active local networks of farmers, Non Governmental Organisations (NGOs), government organisations and researchers to further enrich and build on field programmes (Scarborough *et al.*, 1997). Professionals are trained to be facilitators only.

Farmer participation

Orodho (1990) and Swai *et al.* (1992) highlighted the importance of farmer participation in all the processes that include problem identification and analysis, prioritisation, design, implementation, evaluation and reflection. Only can the technology be adopted and professionals (researchers and extensionists) should be facilitators as illustrated by Scarborough *et al.* (1997) for sustainability.

An example of farmer participation is The Chivi Food Security Project in Zimbabwe (Murwira *et al.*, adapted from: Scarborough *et al.* 1997), where inputs were limited to facilitation only.

The objectives of the project were to help farmers' institutions identify their priority needs, work with local institutions to identify and develop technical options to solve problems by building on existing traditional knowledge and influence government agricultural policies to take into account the production needs of small-scale farmers, such as the communal farmers in Chivi.

Appropriateness of technologies

For technology to be adopted by farmers, it must be applicable and relevant. Contributions from local knowledge are very important and research should be carried out under actual field conditions and not under idealised controlled conditions of an experimental farm. Some authors (Adams, 1982 and Moris, 1991) indicate that strategies to improve appropriateness of technologies have to be backed up by finance and training besides the willingness of the farmers to adopt the technologies. Unfortunately these situations occur in governments where budget allocations are not even enough to last a season, farmers lack resources to contribute

to the cost of research and the diversity of the farmer's environment is more complex.

Costs/inputs involved

Financial services are difficult to access especially by the small-scale farmers as they are viewed as high risk by bankers and have low repayment potential. Availability of financial resources to research and extension can be used as an avenue to boost ability to deliver the technologies to the small-scale farmers. However, this can be overcome by equitable distribution of resources (Moris, 1982), farmer contribution to research and extension (van den Ban and Hawkins, 1996), collaborative research with other institutions both locally and internationally and good planning in allocation of resources.

A study conducted by the author on service delivery to the farming sector in Zimbabwe revealed that financial institutions set lending criteria that does not accommodate the financial needs of small-scale farmers. The farmers end up utilising own finances to support farming activities. The seasonality nature of agriculture and limited irrigation facilities results in farmers producing dry land crops only, of which income is received after at the end of the growing season, if at all anything is harvested.

Gender roles, socio-economic and cultural factors

Strategies that result in shifting of the labour burden to women but leaving the benefits in the pockets of men will not be adopted, if adopted, will not be sustained. Therefore it is necessary to introduce labour saving technologies in the system because new technologies are naturally labour intensive (Bulale, 2000). He adds that the positive effect of education on the adoption of forage production technologies reflects the importance of improving human capital for developmental activities. Farmers' education and training should be given top priority in rural development and should take into account gender roles in the communities.

Attitude change is a process which needs support through awareness and training. Differences in social classes and culture can influence adoption of technologies and to this end Maranga (1990) suggest studies that focus on traditional resource management and production systems to identify constraints and prioritising research.

In the small-scale farming areas of Zimbabwe, women do most of the fieldwork especially on labour intensive crop such as cotton picking and tobacco harvesting. Hanyani-Mlambo *et al* (1998) attribute this to cultural background and lack of institutional support to create awareness. Therefore, there is need to introduce labour saving technologies, as women have been disadvantaged relative to men (van den Ban and Hawkins, 1996). Although attitude change may take longer, participation of all parties will enhance the process. In cotton growing areas, polygamous marriages are more frequent as it is viewed as a source of farm labour.

Summary

With global warming, a number of forage production strategies have been identified on management practices. Forage species should be drought resistant, produce good quality livestock feed, improve soil nutrient status and improved nutrition in the household. As farmers give priority to food crop production, there is need to incorporate forages that are easy to produce and where local knowledge systems can be applied.

Success of forage production management practices depends on farmers adopting new technologies and for such to have an impact, farmer participation is very crucial and should be part of the research that develops these technologies. Successful technologies should also depend on an interdisciplinary teamwork from researchers, extension staff, farmers and other stakeholders. Social acceptability and implementation of forage production technologies will ensure sustainability of the interventions.

REFERENCES

- [1] A. Abate, B. H. Dzowela and J. A. Kategile, "Intensive Animal Feeding Practices for Optimal Feed Utilisation". In: Kategile J.A. and Mubi S (eds). Future of Livestock Industries in East and Southern Africa. Proceedings of a workshop held at Kadoma Ranch Hotel, Zimbabwe, 20-23 July 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia, 1992.
- [2] A. B. Orodho, 1990. Dissemination and utilization of research technology on forages and agricultural by-products in Kenya. In: PANESA/ARNAB (Pastures Network for Eastern and Southern Africa/African Research Network for Agricultural By-products). Utilisation of research results on forage and agricultural by-product materials as animal feed resources in Africa. Proceedings of the first joint workshop held in Lilongwe, Malawi, 5-9 December 1988. PANESA/ARNAB, Addis Ababa, Ethiopia.
- [3] A. I. Bulale, "Smallholder dairy production and dairy technology adoption in the mixed farming system in Arsi Highland, Ethiopia". Landwirtschaftlich- Gartnerischen fakultat der Humboldt-Universitat zu Berlin, 2000.
- [4] A. W. van den Ban and H. S. Hawkins, Agricultural extension 2nd edn, 1996.
- [5] B. Palmer, D. J. Macqueen and R. C. Gutteridge, "Calliandra calothyrsus – a multipurpose tree legume for humid locations. In: Forage tree legumes in tropical agriculture. CAB International, 1994.
- [6] B. T. Hanyani-Mlambo, S. Sibanda and V. Ostergaard, Socioeconomic aspects of smallholder dairying in Zimbabwe. *Livestock Research for Rural Development Journal* vol. 10 no. 2, 1998.
- [7] C.F.U. (Commercial Farmers' Union), Facts on land and the present situation, 2000.
- [8] D. Q. Innis, "Intercropping and the scientific basis of traditional agriculture". Intermediate technology publications, 1997.
- [9] E. K. Maranga, "Utilisation of research results in range production and management systems in Kenya". In: PANESA/ARNAB (Pastures Network for Eastern and Southern Africa/African Research Network for Agricultural By-products). Utilisation of research results on forage and agricultural by-product materials as animal feed resources in Africa. Proceedings of the first joint workshop held in Lilongwe, Malawi, 5-9 December 1988. PANESA/ARNAB, Addis Ababa, Ethiopia, 1990.
- [10] E. S. Swai, F. N. Minja and L. Zylstra, Dairy development programme in Tanga, Tanzania. In: Kategile J.A. and Mubi S (eds). Future of Livestock Industries in East and Southern Africa. Proceedings of a workshop held at Kadoma Ranch Hotel,

- Zimbabwe, 20-23 July 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia 1992.
- [11] Food and Agriculture Organisation (FAO), 2007.
- [12] G. Manyawu and O. Mhere, DR&SS releases new varieties of pasture grass. The Farmer, August, 2001.
- [13] J. F. P. D'Mello and C. Devendra, "Tropical legumes in animal nutrition". CAB International, 1995.
- [14] J. F. Mupangwa, Pasture seed production of promising grasses and legumes at Domboshawa, Zimbabwe, 1996. In: J. Ndikumana and P. de Leeuw, Sustainable Feed Production and Utilisation for Smallholder Livestock Enterprises in Sub-Saharan Africa. Proceedings of the 2nd African Feed Resources Network. (AFRINET), Harare, Zimbabwe 6-10 December 1993.
- [15] J. F. Mupangwa, N. T. Ngongoni, J. H. Topps and H. Hamudikuwanda, "Effects of supplementing a basal diet of *Chloris gayana* hay with one of three protein-rich legume hays of *Cassia rotundifolia*, *Lablab purpureus* and *Macroptilium atropurpureum* forage on some nutritional parameters in goats". *Tropical Animal Health and Production Journal*, 2000.
- [16] J. G. Mureithi and W. Thorpe, "The effects of herbaceous intercropping and mulching on the productivity of Napier grass (*Pennisetum purpureum*) and total forage yield in coastal lowland Kenya, 1996. In: J. Ndikumana and P. de Leeuw, Sustainable Feed Production and Utilisation for Smallholder Livestock Enterprises in Sub-Saharan Africa. Proceedings of the 2nd African Feed Resources Network. (AFRINET), Harare, Zimbabwe 6-10 December 1993.L.
- [17] J. J. Baloyi, N. T. Ngongoni, J. H. Topps, T. Acamovic and H. Hamudikuwanda, "Condensed tannin and saponin content of *Vigna unguiculata* (L.) Walp, *Desmodium uncinatum*, *Stylosanthes guianensis* and *Stylosanthes scabra* grown in Zimbabwe. *Tropical Animal Health and Production Journal*, 2001, 33 pp. 57-66.
- [18] J. Moris, Extension alternatives in tropical Africa. Overseas Development Institute, 1991.
- [19] J. N. Kariuki, "The potential of improving napier grass under smallholder dairy farmers' conditions in Kenya". PhD thesis, Animal Nutrition Group, Department of Animal Science, Wageningen Agricultural University, The Netherlands, 1998.
- [20] L. R. Humphreys, "Tropical Forages: Their role in sustainable agriculture". Longman Scientific And Technical, 1994.
- [21] L. R. Ndlovu, Key issues for sustainable feed production and utilization for smallholder livestock enterprises in sub-Saharan Africa, 1998. In: Ndikumana J. and de Leeuw P. Sustainable Feed Production and Utilisation for smallholder livestock enterprises in Sub-Saharan Africa. Proceedings of the 2nd African Feed Resources Network. (AFRINET), Harare, Zimbabwe 6-10 December 1993.
- [22] L. R. Ndlovu and J. Francis, "Nutrient requirements and feeding systems for draught animals". In: Performance and nutritional management of draught cattle in smallholder farming in Zimbabwe. University of Zimbabwe Publications, Harare, 1997.
- [23] L. V. Crowder and H. R. Chheda., Tropical Grassland Husbandry. Tropical Agriculture Series. 1982.
- [24] M. E. Adams, "Agricultural extension in developing countries", Longman group, 1982.
- [25] M. Titterton, O. Mhere, T. Kipnis, G. Ashbell, Z. G. Weinberg and B. V. Maasdorp, "Development of ensiling technology for smallholder cattle owners in Zimbabwe". In: Silage making in the tropics with particular emphasis on smallholders. Proceedings of the FAO electronic conference on tropical silage. September – 15 December 2000.
- [26] O. Mhere, B. Maasdorp and M. Titterton, "Forage Production and Conservation Manual. Growing and ensiling annual and perennial forage crops suited to marginal and semi-arid areas of Southern Africa", 2002
- [27] P. J. Skerman, D. G. Cameron and F. Riveros, "Tropical Forage Legumes". 2nd Edn. FAO, 1988.
- [28] P. J. Skerman and F. Riveros, "Tropical Grasses". FAO Plant Production and Protection Series, 1990.
- [29] R. Chambers, "Challenging the professions: frontiers for rural development". Intermediate Technology Publications, 1993.
- [30] R. Humphreys, "Tropical Pastures and Fodder Crops". 2nd Edn. Intermediate Tropical Agriculture Series 1987.
- [31] R. Muchadeyi, "Herbage yields, chemical composition and *in vitro* digestibility of dual purpose legumes intercropped with maize for forage production". MSc. thesis. University of Zimbabwe, 1991.
- [32] R. Muchadeyi, H. Nemasasi, N. Chikumba, W. Mupangwa, B. Z. Mugweni, C. Kuwaza and I. Chakoma, "Biological nitrogen fixation and forage production in cereal-legume intercropping systems in Wedza and Buhera". Annual report for Biotechnology Trust of Zimbabwe, livestock project, 2001.
- [33] R. S. Caffarella, "Program development and evaluation resource book for trainers". Virginia Commonwealth University Richmond, Virginia, 1987.
- [34] P. York and E. Nyamadzawo, Rhodes grass breeding in Zimbabwe: aims, achievements, prospects and route to agricultural applications, 1990. In: PANESA/ARNAB (Pastures Network for Eastern and Southern Africa/African Research Network for Agricultural By-products). Utilisation of research results on forage and agricultural by-product materials as animal feed resources in Africa. Proceedings of the first joint workshop held in Lilongwe, Malawi, 5-9 December 1988. PANESA/ARNAB, Addis Ababa, Ethiopia.
- [35] V. Scarborough, S. Killough, D. A. Johnson and J. Farrington (eds), Farmer-led extension. Concepts and practices. Intermediate Technology Publications, 1997.
- [36] W. Bayer and A. Waters-Bayer, "Forage Husbandry" In The tropical agriculturalist, 1998.

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