Book of Abstracts

24-oct

9:45-10:15 □ *Poudyal et al*: "Shea regeneration dynamics in fields and fallows of West Africa: an empirical study from Burkina Faso and Mali" – an overview of field work and results

The impacts of land use practices on the distribution of shea trees, and particularly on the regeneration of shea have been highlighted in recent years. However, earlier studies have focussed on rather broad categories of field vs. fallow/bush, and hence miss out on the detailed impacts that varying lengths of continuous farming or fallowing of lands might highlight. Furthermore, due to pressure on land and land scarcity, not only the fields are being cultivated on continuously for extended periods, the fallow periods are also getting shorter in many areas. This calls for a more thorough study on the impact of these land use practices on the regeneration of shea in these different land use systems. This study aims to contribute significantly in this regard by studying the regeneration of shea in fields and fallows of different ages - i.e., lands that are cultivated or left fallow for different period of time. Using data from permanent plots from three study sites each in Burkina Faso and Mali, covering the north-south gradient of shea distribution range, and collected over the end of rainy and dry seasons during 2007-2008, this study analyses the impact of land use and other factors, such as adult tree density, seasonality and climatic gradient on the regeneration of shea trees in Burkina Faso and Mali. We analyse the data in two steps: (i) comparative descriptive analysis of shea regeneration (measured as seedling count) between different sites and land use types with tests of significance; and (ii) (count data) modelling of shea regeneration to explore more thoroughly the factors that significantly impact shea regeneration.

As expected, fallow plots, in general, had significantly higher regeneration than field plots. However, there were significant variances with field and fallow plots of different ages: new and medium fields had higher regeneration than old fields; old fallows had higher regeneration than new and medium fallows. The importance of land use history on shea regeneration is also highlighted by the fact that shea regeneration in new field was twice as much as in old field, and regeneration in old fallow five times as much as in old field. In terms of climatic gradients, Northern sites have low shea regeneration in both field and fallow compared to Central and Southern sites. In terms of country-wise comparison, Burkina Faso had significantly higher regeneration on average than Mali. In both countries studied, differences in regeneration between field and fallow is more pronounced in Central sites, which is likely to be pointing to the impact of high population pressure and high land scarcity in these areas, which needs to be further investigated. Moreover, interaction between land use and shea density highlights an important issue in shea regeneration: increasing adult shea density in fallow plots is likely to reduce shea regeneration, which could be due to increased competition for space in area already with healthy adult shea density and regeneration.

The estimated model predicts that for fallow plots in Mali at the end of rainy season, 10% and 20% increase in adult shea densities are likely to increase shea regeneration by about 2.2% and 4.5% respectively, starting adult shea density fixed at 44.44,/ha which is the average adult shea density for fallows in Mali. For Burkina Faso, the corresponding changes for shea regeneration are 2.7% and 5.5% respectively, the base adult shea density for fallows in this country fixed at the average shea density for fallows of 53.5/ha. In contrast to the fallows, impacts of changes in adult shea density on shea regeneration are more pronounced in fields for both Burkina Faso and Mali. The results indicates that a 10% and 20% increase in adult shea densities in fields at the end of rainy season is likely to increase shea regeneration by about 7.1% and 14.8% respectively for Burkina Faso (starting adult shea density fixed at field average of 36.3/ha), and by about 8.5% and 17.7% respectively for Mali (starting adult shea density fixed at field average of 42.9/ha). This fact is highlighted further by the regression results, which show that although the magnitude of shea regeneration are significantly higher in fallows compared to fields, marginal changes are much more significant for fields, i.e., changes main factors, such as adult shea density, is more likely to significantly change shea regeneration in field than in fallows.

This analysis uses data only from Burkina Faso and Mali at present due to data compatibility between these two countries in terms of year and season of collection, and matching climatic gradient. However, the analytic technique and models used in this analysis can easily be extended to analyse similar regeneration data from other countries such as Ghana, Senegal and Uganda, either country-wise or as integrated data (if the data collected are compatible).

10:45-11.05 *Kabore et al* "Dynamic of regeneration of shea tree on fields and fallows in Sobaka, Burkina Faso" – more details from Burkina.

In many parts of Africa, agroforestry is a common practice using several species. In the Soudan zone of West Africa, shea tree (*Vitellaria paradoxa*) is by far the most preferred and used by local populations. *V. paradoxa* is an important agroforestry species of ecologic and socioeconomic interest. Unfortunately its populations decline in parklands. The loud lack of regeneration during many years has led to this situation. So, our research assesses climatic factors and human pressure impacts on the juveniles of the species *in situ.*

The aim of this study is to contribute to the sustainable management of shea tree for its long-term preservation. The general objective is to assess the impacts of farmers' practices on the natural regeneration of shea tree. The specific objectives are: (1) to estimate the recruitment, the mortality and the growth of seedling according to the type of land use; (2) to test if the ages of fields and fallows have an influence on the regeneration.

The study was carried out at Sobaka, a village located 75 km south of Ouagadougou (Burkina Faso) with 900 mm of annual rainfall. Stratified and randomized sampling was used to install three plots of 50 m * 50 m (2500 m^2) in each type of lands, which are: young fields (2 years old), intermediate age fields (6 years old), old fields (more than 15 years old), young fallows (2-3 years old), intermediate age fallows (6-8 years old) and old fallows (more than 15 years old). The height of all individuals, adult and juveniles, was measured, and theirs positions were recorded by GPS. Each plot was subdivided into sixteen small squares of 12, 5 m * 12, 5 m, and six of them were chosen for the monthly counting and growth measurement (height and collar diameter) of the juvenile from December to September.

The result showed that sapling of 1 to 4 m of height is absent in fields (only 2,7 ± 2,3 saplings/ha) because farmers don't preserve any seedling during field works. In contrast, an important regeneration is found on fallows. The density was 1150 ± 1052 seedling (< 1m) /ha in the young fallows, 1406 ± 591 seedling/ha in the intermediate age fallows and 2121 ± 2566 seedling/ha in the old fallows. The analyses of spatial structure of the shea tree populations revealed that the juveniles are aggregated surround the adults only on fallows. During the dry season from December to May, the stems of 54 % to 84 % of the juveniles become dry. The lack of water and the height temperature (40°C in April) are the main cause. In addition, bush fires, particularly the last one in February, are very deadly for regeneration. The plants are regenerated when the wet season appears on June, and the initial number of juveniles is finding again. The average growth of juveniles, 1, 7 cm during ten months, is significant only in old fallows. Faced with the fallows disappearance, we recommend farmers to keep few seedling and sapling in their fields.

11:05-11:25 *Kelly et al.* "Regeneration of shea tree in fallows of different ages along the north-south gradient of shea distribution in Mali (West Africa)" – more details from Mali.

Vitellaria paradoxa is a parkland forest tree species covering a wide range of agro-ecological zones and playing important economical and ecological roles. Many studies highlighted the constraints the species is facing among which degrading populations and lack of regeneration in the fields.

Three sites were selected following a north-south gradient using climatic index to study shea regeneration in different types of land use and history. Eighteen permanent plots of 50 x 50 m (0.25 ha) were established in each site. Each permanent plot was split into 16 subplots of 12.5 x 12.5 m. Five (5) subplots were chosen at random and shea regeneration was monitored from 2007 to 2011.

Seedling (RN class 1: height = 0 - 50 cm) occurrence is highly varying according to site, land history and year. The centre site (Mperesso) and particularly the old fallows shown the best occurrence of seedlings. The highest number of seedlings observed during the monitoring period was 646 seedlings obtained in old fallows at Mperesso in 2009. The other categories of regeneration particularly RN class 3 (height = 101 - 150 cm) are few in centre site (Mperesso) and in the north site (Daelan). Regeneration growth is slow; the south site (Nafégué) offered the best occurrence of other categories of regeneration and globally the best growth. The highest mean height for RN class 2 (81.75 cm) was observed at Nafégué in old fallows during 2008. For RN class 3, the highest mean height (145 cm) was observed in medium fallows at Nafégué in 2010.

Shea regeneration (seedling) occurs in all sites but is facing several constraints. These constraints are causing important mortality reducing the number of plants reaching the stage of saplings and above. The growth of surviving individuals is also affected by these constraints yielding an important variation of mean height which is often decreasing.

11:25-11:45 *Byakagaba el al.* “Population structure and regeneration on status of *Vitellaria paradoxa* under different land management regimes in Uganda”.

Vitellaria paradoxa is an important indigenous tree in the savanna woodlands of Africa contributing immensely to livelihoods in areas where it occurs. Because of its importance to the shea parkland communities, there is need to clearly understand its population structure and regeneration status under different land management regimes in Uganda. I n this study, an assessment of population structure and regeneration of *V. paradoxa* under three land management regimes was carried out in four shea districts using a 0.25ha sampling plots. The aim of the study was to determine the size class distribution plus density of seedlings, saplings and mature *V. paradoxa* trees. The diameter at breast height (dbh) of all mature trees and the diameter at crown base of saplings were measured. Seedlings were enumerated and their collar diameter measured. The population was described using density, size class distributions and their slopes. Generalised linear model analysis was used to compare the density in each size class among the different land management regimes. Seedling density varied among the land management regimes while sapling and mature tree densities did not. Seedling density was highest in young fallows followed by old fallows and current-farm fields respectively. Size class distribution and regeneration varied with land management regimes across all sites. The best regeneration of shea tree was observed in the young fallows followed by old fallows and current-farm fields respectively. This study confirms that land management regimes can influence the population structure and regeneration status of *V. paradoxa* in the shea parklands of Uganda. In general, young fallows favour the regeneration and maintenance of more stable and healthy *V. paradoxa* population compared to old fallows and current-farm fields respectively.

11:45-12:05 *Okullo et al.* “Spatial distribution of the shea butter tree in Uganda”.

Vitellaria paradoxa (the shea butter tree); an indigenous fruit tree in Uganda is highly valued for fruits, nuts, oil and other non wood products by the shea parkland communities. Since there are also other important indigenous plant resources of subsistence and economic values within its niches, this study aimed at establishing distribution of the shea butter tree as well as generate spatial distribution map of *V. paradoxa*.subsp.nilotica within the Ugandan shea parkland. Transects of 1,000 m long were established and plots of 50 x 40 m were demarcated at 200 m intervals in each shea district. In each plot, shea and other associated tree species were counted and GPS coordinates of all plots were taken. Plot data were entered in Ms Excel to generate densities of the different size classes while the GPS and inventory data were analysed in GIS Arc Map to generate shea distribution maps. ANOVA was used to test the difference between shea densities while Pearson correlation analysis was used to test the relationship between human population and shea densities. Shea densities varied with land use types. The least densities were recorded on homesteads and on farms comprising mainly of mature shea trees. The densities of juveniles, poles and mature shea plants were more stable in fallows. Although the densities of shea juveniles were highest in conservation areas and forest reserves (40 plants/ha), the conservation areas showed considerable decline in the densities of poles and saplings (2 stems/ha). The densities of mature, poles/saplings and juveniles of *V.paradoxa* varied considerably. There was a significant difference in the mean number of mature shea, sapling/poles and juveniles ($p \leq 0.05$) and a weak negative correlation between human population and shea densities ($R^2 = -0.226$; $p = 0.26$). This study suggests that fallows can support a more stable shea population than other land uses and increases in human population are the greatest threats to survival of the shea parkland species (due to high extractive use pressures and need for crop cultivation). Enrichment planting, on-farm integration of *V. paradoxa* and promotion of non extractive activities such as bee keeping and incentives such as the carbon fund alongside enforcement of local environmental byelaws are needed to encourage community’s participation in conserving the shea parkland trees in Uganda.

13:-30-13:50 *Chimsah et al*. "Diversity of tree species in cultivated and fallow fields within shea parklands of Ghana".

Tree species diversity associated with shea in cultivated and fallow fields of shea parklands of Ghana was studied. The study was to assess tree species diversity in relation to land use type across a North – South gradient of shea growing sites in Ghana. The study was conducted in 2011 at Paga, Nyankpala and Kawampe. In addition to shea trees, other highly valued tree species are preserved in parkland systems because of their ability to improve soil fertility and increase crop yield In addition to reducing microclimatic extremes as well as wind and water erosion, parkland trees are important sources of income and nutritional security. There is the need to reserve other tree species so as to reduce the over reliance of the shea tree as a source of product other than its economic value. Fifty four (54) quadrats measuring 50 x 50 m (18 in each location) were used as experimental plots. Diversity of higher woody plants was analyzed using the Simpson Diversity Index (*D*). A total of 863 plant species were studied. The total density of tree species in cultivated and fallow fields was 64 and 355 for Paga, 39 and 130 for Nyankpala, 75 and 200 for Kawampe. Shea densities from the study showed that there were more shea trees in fallow fields (469) than cultivated fields (298). The main species identified in the study were *Diospyros mespiliformis* Hochst, *Annona senegalensis* Pers, *Azadirachta indica* A. Juss, *Diospyros mespiliformis* Hochst, *Terminalia albida* Sc Elliot and *Senna siamea* Lam. These species accounted for 54.8 % of all species. Fallow fields were more species composed (33 species) than cultivated fields (21 species). The results showed differences in diversity based on locations with Paga and Nyankpala showing high species diversity of 0.95 each in cultivated and fallow fields respectively. However, significant differences ($P < 0.005$) in species diversity were not observed in all three study sites within cultivated and fallow fields.

13:50-14:10 *Bayala et al* "Morphological traits and photosynthesis of seedlings of *Vitellaria paradoxa* under water stress in nursery in Burkina Faso".

The ecophysiological response of the seedlings of eight African provenances of *Vitellaria paradoxa* to water constraint was studied in experimental conditions. Fifteen month-old young seedlings, raised in pots, were subjected to three different water regimes (R1: 100% of the field capacity; R2: 75% and R3: 50%) and the watering was done each three days. The objective of this study was to determine the provenances of shea tree which adapts or which resists to water deficit. The nuts were sown and after germination, the seedlings were transplanted in aluminum pots in a nursery at Ouagadougou (Burkina Faso). A split plot design was used with the main plots attributed to the provenances and the subplots to water regimes. During this experiment transpiration, net photosynthesis, stomatal conductance and the morphological variables of leaves were measured three times. Measurements of height and diameter were done every month. The results obtained before the application of the stress showed that transpiration and net photosynthesis differed from one provenance to another. Similar trends were observed for dendrometric parameters and morphological parameters of the leaf. With regard to water regime effect, the results showed that a prolonged water stress strongly affected the transpiration, photosynthesis and the stomatal conductance. The poor physiological functioning of the seedlings of regimes 2 and 3 due to the stress resulted in a poor development of leaves and a reduction of the growth in height and diameter of the seedlings. All provenances were severely affected by the water stress. This study did permit to separate the provenances between the most resistant and the most vulnerable to water stress. However the provenance of Uganda displayed the lowest mean values whatever are the variable and the water regime, thus showing its poor adaptation to the climate of West Africa. This type of investigation, which gives an idea of the effect of a possible climatic change which would result in a dryness, must be continue and expand to other species.

14:10-14:30 □ *Abukari et al.* "Comparative studies of soil characteristics in three shea parklands in Ghana".

An assessment of soil physical and chemical properties was carried out in shea parklands of northern Ghana, selected along a north-south climatic gradient in 2011. The study sites were Paga, Nyankpala and Kawampe, which are located in the transitional and guinea savannah zones of Ghana. For each site, 9 fallows and 9 cultivated fields were used, a total of 18 plots per site. Soil samples were collected at a depth of 0-30 cm and analysed for particle size distribution, pH, organic matter (OM), nitrogen (N), phosphorus (P), exchangeable bases, exchange acidity and Effective Cation Exchange Capacity (ECEC). The results revealed the soils were strongly acid to neutral in reaction with soils at Nyankpala parkland being comparatively more acidic (pH < 6). However, the pH values recorded were within the range desirable for plant nutrient availability. Levels of, OM, ECEC, and Total Exchangeable Bases (TEB) were very low, and varied across the parklands, with Nyankpala parkland showing higher levels of OM and ECEC. In spite of the low pH, the soils were highly base saturated (PBS > 80%) and deficiencies of basic cations were uncommon. The Levels of N, P, Ca, and Mg are not indicative of very fertile soils, but they are similar to values reported for wider savannah areas of northern Ghana. The extremely low P content (trace – 19 mg/Kg) of the soils might be due to P fixation which is commonly reported for soils in northern Ghana. Land use did not influence the soil physical and chemical properties except for soil particle size especially at Nyankpala. The levels of N and P reported could promote regenerations as shea seedlings respond positively to N and P.
NB: Please note that the levels of N and P are extremely low so if Shea responds positively to N and P then the statement in red above will not hold.

14:30-15:00 □ *Gwali et al* "Traditional shea tree conservation practices in Uganda: Lessons for conservation science".

Local community conservation of the shea tree is governed by a complex mix of traditions, customs, taboos, rituals and legends handed down from generation to generation and are neither found in written form, nor organized and structured in ways accessible to science. This study was conducted to document major traditional practices in Uganda. Fifteen focus discussion groups as well as 41 key informants and 300 respondents from 9 districts (3 farming systems) within the shea belt of Uganda were interviewed between April 2008 and March 2010. The traditional conservation practices documented range from shea tree and fruit ownership to traditional punishments for errant community members who disregard the local norms. The erosion of these traditional conservation practices have been attributed to wars, poverty, western education and other external influences. Promoting the use of mass media, action plays/drama and public awareness are suggested as some of ways to reduce the erosion of these traditional conservation practices.

15.30-15:50 □ *Bazié et al.* "Linking leaf and root phenologies of *Vitellaria paradoxa* in an agroforestry parkland system in Sobaka, Burkina Faso".

Shea-tree root observations have been performed for more than two years (September 2008 to November 2010) with field rhizotron technique taking into consideration two factors which were the type of land use (farmed field and fallow) and tree growth stage (young and adult). Root dynamics was correlated positively to seasonal variations with high root production starting in April, June or July for village, field and fallow growth conditions respectively and stopping abruptly in September-October when wet season ceased. Coarse and fine root elongation rates followed the same pattern over the entire year with maximal growth speed observed in August – 0.24 $cm.d^{-1}$ and 0.11 $cm.d^{-1}$ for coarse and fine roots respectively. Root elongation rates seemed to be higher in field than village and fallow conditions respectively but without significant differences probably because of high variations between years. Young Shea trees have produced more roots (10.2 $m.m^{-2}$) than adult trees (5.7 $m.m^{-2}$) in field and fallow conditions in year 2010 which was the year were the annual root production amount 7.9 $m.m^{-2}$, far from 2008 (4.1 $m.m^{-2}$ but uncompleted year) and 2009 (1.4 $m.m^{-2}$ but technical problems with damaged rhizotrons). Interception of the green foliage showed a clear seasonality, with a minimum during the dry season (January to June), thus corresponding to a phase where the trees were severely defoliated. Interception was at its maximum in November 2009, thus corresponding to the maximum of leafing. In 2009 (Sept to Dec), transmittance was higher than in the corresponding months of 2008, indicating the occurrence of some inter-annual variability. Other images were acquired during 2010 and 2011, waiting for analysis. The SD was similar when trees were partially or totally defoliated (February to May 2009). Interception in the "Juvenile-Fallow" treatment was similar (a bit lower) during the dry season, but larger during the wet season, indicating that the "Juvenile-Fallow" trees displayed a larger leafing during the wet season. The magnitude of LAI change (max-min for one given year) was larger in the "Juvenile-Fallow" treatment, indicating that water stress could have been more severe here. Leaf and root dynamics followed the same pattern: roots were produced when leaves were emitted starting from May-June when the first rains appeared and roots stopped growing in November while first leaves started to fall. Some data are missing (leaf interception in 2010) that could not allowed us to match root and leaf dynamics over the entire observed period.

15.50-16:10 *Gerald et al* "Tree diversity in the *Vitellaria* savannas of Uganda in relation to land management practices".

Savannas occupy 20% of the land surface of the earth and they contribute immensely to national economies. It is predicted that savannas are some of the most sensitive ecosystems to future land use changes and therefore understanding their current status in relation to land use patterns is useful in developing strategies for their sustainable management. Despite studies done elsewhere showing that land management practices can affect the savannah woody vegetation composition knowledge on human influence on tree diversity in the *Vitellaria* savannas of Uganda is still limited. This study aimed at assessing the current status of tree diversity under distinct land management practices in the *Vitellaria* savannas of Uganda. The specific objectives were; to determine species richness and species diversity of trees under different land management practices. We hypothesized that species richness and diversity of trees do not vary with land management practices in the *Vitellaria* savannas. Four districts representing the different regions of the Shea belt of Uganda were selected. One site was selected subjectively from each of the district based on the presence of fallows and cultivated land. Fallow land was further categorised as "old and young" depending on the duration under which it had been under fallow. Thirty square plots of 0.25 ha were established along a transect in each of the land management categories. All woody plants (≥ 5cm in diameter) were enumerated and recorded. Species richness was displayed using species accumulation curves while Chao 2, Jacknife 2 and rarefaction curves were used to estimate species richness. Species rank abundance curves were also generated to examine the pattern of relative abundance between species under the different land management practices. Margalef's species richness index was generated for each plot to represent species richness. Species diversity was analysed using Simpson's diversity index. One way ANOVA was used to compare species diversity and richness under the different land management practices. All species richness estimators showed that old fallows had high species richness compared to young fallows and current fields. There was a significant difference in the species richness and diversity recorded in the different land management practices. The study confirms that tree species diversity and richness in the *Vitellaria* savannas of Uganda are influenced by land management practices. Keeping land under long fallows would result into relatively high tree species richness and diversity compared to short fallows and current fields respectively. Land owners need to be encouraged to keep their land under long fallows in order to enhance tree species richness and diversity.

16.35-16:55 *Compaoré et al* "Famers' varieties of shea tree in Burkina Faso: identification characterization using the biometrical describers"

The Shea tree (*Vitellaria paradoxa* C. F Gaernt) Hepper is a typical Sapotaceae of the Soudanian and south sahelian zones. Semi tamed species its fruit and almonds are consumed and sold, giving some incomes to the farming communities and, thus fighting against poverty.
Although numerous studies revealed the strong variability inter and intra population, none of them described its genetic diversity within the species with precision. In addition, these studies were made without the producers' involvement, guarantors of the management of the genetic resources. Unlike the preceding studies, the current one deals with the identification of the forest varieties with the help of the producers' describers on two populations of the Shea tree in Burkina Faso namely Dindéresso and Diabo. The results consigned as a matrix of variables show that the producers use 19 key describers in total to distinguish one Shea tree from another. These describers are classified on three levels whose 5 on the scale of the size and the conformation of the top of the tree, 4 on the scale of the leaves, and 10 on the scale of the fruit. The use of nine of these most relevant describers, based on the characters of the leaves and fruit has permitted to characterise four (4) forest varieties of the Shea tree from the descriptive analyses (ACP and CAH).

16:55-17:15 *Sanou, H.* **"**Famers' varieties of shea tree in Mali"

To domesticate shea butter tree, an important species of agro-forestry parklands, it is important to survey farmers´ knowledges, to identify and characterize the morphotypes; and to propagate superior genotypes in order to bring species into wider cultivation. Surveys conducted in Mali have shown that farmers have knowledges on shea which vary according to the abondance and to the socio-economic importance of the species in the region. Farmers´ preferences and selection criteria were identified The criteria varied according to ethnic groups. Based on these criteria, 145 accessions were identified which were clustered in 15 groups. Some of the morphotypes are the same but have different names du to the difference in ethnic groups. When comparing the morphotypes to the global population of shea in Mali, significant difference was observed for all main fruit traits except for the nut weight (F=2.67 and Prob=0.128. The distribution pattern showed that the morphotypes are distributed throughout the country. Chemical analyses of the nuts showed the same trend. Plus trees were identified according to fat content; some of them were propagated on farm for establishment an improved gene pool which was supposed to provide regularly material for propagation to farmers.

8:30-8:50 □ *Gwali et al* "Morphological variation among shea tree 'Ethno-varieties' in Uganda".

Vitellaria paradoxa C. Gaertn. (shea tree) is an indigenous tree species widely spread in the drier areas of northern and eastern Uganda. The tree is widely known for its oil which is used in cooking, cosmetics and traditional medicine. Local folk classification by farmers recognises the presence of 44 ethno-varieties on the basis of fruit and nut characters. Morphological variation was analyzed in shea tree ethno-varieties in West Nile, Northern and Teso farming systems to (1) assess the patterns of morphological variation among shea tree ethno-varieties and (2) establish whether there is morphological evidence for shea tree folk classification in Uganda. Knowledge of fixed variation is important for any breeding or conservation programme. A total of 176 shea trees representing all the 44 farmer ethno-varieties were analysed for 14 fruit, nut, leaf and tree traits. Morphological measurements were made on 40-50 leaves, 20-30 fruits, crown and stem diameters for a maximum of 5 trees of each ethno-variety in the three farming systems. Pearson's correlation coefficients, Principal Component and Hierarchical Cluster Analysis were utilised to explore and reveal patterns in morphological variation among the ethno-varieties. High variation was found in pulp weight (CoefVar = 35.9%), DBH (CoefVar = 28.48%), fruit weight (CoefVar = 27.81%) and canopy diameter (CoefVar = 26.69%). Apocopoco (soft pulp variety) had the heaviest fruits, nuts and pulp while Acula (oval fruit variety) had the longest fruits. There was strong positive correlation between pulp and fruit weight ($r = 0.963$, $p < 0.001$), leaf length and leaf width ($r = 0.652$, $p < 0.001$) and between petiole length and leaf length ($r = 0.788$, $p < 0.001$). Principal component analysis showed no underlying quantitative morphological structure among the 44 ethno-varieties. Hierarchical cluster analysis revealed the presence of five groups with no clear aggregation based on ethnographic or geographic separation. From morphological evidence alone, there are no discrete forms of *V. paradoxa* related to folk classification Uganda. However, the high variation in fruit characteristics offers great opportunities for cultivar selection for improvement and domestication programmes.

25. Oct

8:50- 9:15 □ *Kjaer et al.* "Domestication: a route to better Shea?

In this presentation we discuss domestication as a tool to improved Shea. We present the framework and experience from domestication of Shea and other Sudano-Sahelian fruit trees. We highlight knowledge gained in INNOVKAR and outline likely new routes towards improvement that results from the project open for future activities. The IINOVKAR project has moved the present level of understanding substantially forward in relation to basic pre-breeding knowledge, and has thereby put the West African countries in a position where they can now develop country specific or regional breeding programmes. But what should such programmes include, what are the likely effects and how can they be organised?

9:15-9:45 □ *Bouvet el al:* "Can provenances of shea be delineated into regions?"

9:45-10:05 □ *Compaoré et al* "Biometrics characters of trees, leaf and kernels of 6 ecotypes of shea (*Vitellaria paradoxa*) in Burkina Faso"

Leaf and fruit parameters of *Vitellaria paradoxa* populations in north-south gradient of the shea belt in the transitional and Guinea Savannah zones of Ghana were compared during the fruiting season between April to July, 2011. Thirty five trees which were at least 50 m apart and with diameter at breast height of at least 20 cm were randomly selected from each of the three locations namely Paga , Nyankpala , Kawampe for the studies. Leaf morphological traits studied include laminar width, petiole and laminar lengths. Fruit parameters measured include fruit and kernel widths, lengths, weights and pulp weight. Results showed variability for most of the characters determined. The leaves in Paga had shorter petioles as compared to those of Nyankpala and Kawampe. The Nyankpala *V. paradoxa* has the smallest laminar width whilst Kawampe has longest leaf laminar as compared to the rest. Values for fruit and kernel parameters were highest for samples from Paga, followed by Kawampe and were significantly higher than those from Nyankpala. There were significant positive relationships between fresh fruit weight and both fresh kernel weight ($P < 0.001$; $R^2 = 0.6925$) and dry kernel weight ($P < 0.001$; $R^2 = 0.6532$) for data pooled from all the three locations, however, the slopes and intercepts varied between locations ($P < 0.001$). The result from the study provides opportunities and prospects for selection and breeding for *V. paradoxa* tree improvement in Ghana.

10:35-10:55 *Nyarko et al* "Leaf and fruit characteristics of shea in Northern Ghana".

The shea tree, *Vitellaria paradoxa* (Gaertn. F.) Hepper, is an oleaginous plant which leads to the spontaneous state in sudanian savannas. Its interest lies in its fruits and butter resulting from almonds collected in the natural formations and the parks agroforestiers. The interest of butter transcends today the borders of its surface of distribution. However, to lead to a domestication of the species, it is significant to capitalize certain basic scientific information. In this report/ratio, the study related to the variability of the phenotypical characters of the leaves and seeds. On the leaves, measurements were made on the length and the width of the limb, the length and the diameter of the petiole, the point angles and with the base of the limb, the number of secondary veins. On seeds measurements related to the length, the width, the fresh weight and the dry weight of seed and the dry weight of almond. From the length of the limb and number of secondary pairs of veins we calculated the density of the veins. The leaves and the fruits were collected on the same tree. Eight populations divided into longitudinal and athwart ship gradient were used as framework of study. The number of trees selected inside each population varies between 9 to 20 individuals. A variance Analysis was made variable by variable according to model GLM, was followed of an analysis simultaneously of all the variables (leaves and fruits) using an Analysis in principal Components (ACP). As well on the leaves as on seeds, the results reveal a strong morphological variability inter population and inside the populations. The linear study of regression made on the variables of seeds, shows strong relations between the variables of the leaves on the one hand and those of seeds of other shares. The analysis multi varied made simultaneously with all the variables revealed the existence of 8 sub-groups. At the level of the leaves, the study highlighted 4 morph types for the length of the limb, 4 for the width of the limb and 4 for the length of the petiole. In conclusion, strong variability observed, will make it possible to make a selection of the trees < < more > > to protect for domestication of the species.

10:55-11:15 *Paré, et al* "Provenances trial of shea: Variation of the biometric characters of kernels and seedling according to containers used in nursery ".

11:15-11:45 *Allal,, et al.* "The phylogeography of *Vitellaria paradoxa* over Africa".

In this project, we investigated the impact of historical events such as the last glacial maximum (LGM) and other more recent factors such as human agricultural practises, on the present genetic pattern of *Vitellaria paradoxa* (shea tree) by adopting two sampling strategies: the first concerned all the natural range and the second more specifically the West Africa range with a very dense sampling.
A range-wide sampling of the species enabled us to sample 374 individuals from 71 populations distributed throughout sub-Sahelian Africa. Trees were genotyped using 3 chloroplasts and 12 nuclear microsatellites, and were sequenced for 2 polymorphic chloroplast intergenic spacers. Analyses of genetic diversity and structure were based on frequency-based and Bayesian methods. Potential distributions of *V. paradoxa* at present, during the LGM and the last interglacial period, were examined using DIVA-GIS ecological niche modelling (ENM). Haplotypic and allelic richness varied significantly across the range according to chloroplast and nuclear microsatellites, which pointed to higher diversity in West Africa. A high but contrasted level of differentiation was revealed among populations with a clear phylogeographic signal, with both nuclear (F_{ST}=0.21; R_{ST}=0.28; R_{ST}>R_{ST} (permuted)) and chloroplast simple sequence repeats (SSRs) (G_{ST}=0.81; N_{ST}=0.90; N_{ST}>N_{ST} (permuted)). We identified a strong geographically related structure separating western and eastern populations, and a substructure in the eastern part of the area consistent with subspecies distinction. Using ENM, we deduced that perturbations during the LGM fragmented the potential eastern distribution of shea tree, but not its distribution in West Africa. Our main results suggest that climate variations are the major factor explaining the genetic pattern of *V. paradoxa*.
In Western Africa, eleven nuclear microsatellites (nuc) were used to genotype 673 trees selected in 38 populations. They revealed moderate to high within-population diversity: allelic richness ranged from R_{nuc}=3.99 to 5.63. This diversity was evenly distributed across West Africa. Populations were weakly differentiated (F_{STnuc}=0.085; P < 0.0001) and a pattern of isolation by distance was noted. No phylogeographic signal could be detected across the studied sample. Additionally, two chloroplast microsatellite loci, leading to 11 chlorotypes, were used to analyse a sub-set of 370 individuals. Some variation in chloroplast allelic richness among populations could be detected (R_{cp} =0.00 to 4.36), but these differences were not significant. No trend with latitude and longitude were observed. Differentiation was marked (G_{STcp}=0.553; P < 0.0001), but without a significant phylogeographical signal. Population expansion was detected considering the total population using approximate Bayesian computation (nuclear microsatellites) and mismatch distribution (chloroplast microsatellites) methods. This expansion signal and the isolation by distance pattern could be linked to the past climatic conditions in West Africa during the Pleistocene and Holocene which should have been favourable to shea tree development. In addition, human activities through agroforestry and domestication (started 10 000 BP) have probably enhanced gene flow and population expansion.

These complementary samplings and analyses stressed the factors explaining the evolutionary divergence among sub species and populations in the different regions of the natural range. These studies should be associated with agromorphological and ecophysiological analyses to understand other factors explaining diversity for example the impact of local conditions (soil, climatic, human, etc.).

13:15-13:45 □ *Piombo, et al*. "Shea nuts oil characterization"

Nuts samples were collected over two years (2007 and 2008) in homogeneous conditions in four West African countries (Subsp. *paradoxa*): Senegal, Mali, Burkina and Ghana; and 1 East African country (Subsp. *nilotica*): Uganda. Within each country different sites according to a north-south gradient were sampled. Sampling represented a total of 624 trees (GPS located) collected in 17 sites: Senegal (Kenioto, Samecouta and Saraya), Mali (Nafégué, Mperesso, Daelan, Tori and Sassambourou), Burkina (Titao and Guibare), Ghana (Kawampe, Tolon and Kulbia) and Uganda (Katakwi, Pader, Moyo and Uleppi-Arua). An average of 30 mature fruits was collected per tree. Post-harvest treatment including depulping and drying (3 days at 60°C), has been done onsite. The dried nuts were sent to CIRAD laboratory Montpellier (France). At receipt nuts were oven-dried two days at 60°C in order to stabilize moisture content, then stored at room temperature before analyzes.

Powders prepared from collected nuts were analyzed for moisture content, fat content using solvent extraction, fatty acid (FA) profiles using gas chromatography, tocopherols content using HPLC with fluorimetric detector, Triacylglycerols (TAG) profiles using HPLC and free fatty acids (FFA) using potassium hydroxide neutralization.

Fat content was on average equal to 49.66%, the values ranged from 29.96% to 59.66%. Oleic acid relative percentage was systematically higher than stearic acid. However East African shea butters were richer in Oleic acid (56.64%) than West African butters (45.91%). At the opposite, Stearic acid relative percentage was higher in West Africa (40.91%) than in East Africa (29.72%). According to oleic and stearic acids relative proportions, 2 groups corresponding to East and West Africa, were defined.

Only α-tocophérol and γ-tocophérol were detected in the samples, α-tocophérol was preponderant with an average content equal to 112 mg/kg while γ-tocophérol was ten times less concentrate. In Uganda γ-tocophérol was three times more concentrate than in West African shea nuts. TAG profiles were fully described including isomeric position by Liquid Chromatography and Mass Spectroscopy. TAG profiles revealed SOO and SOS were preponderant. SOS was higher in West Africa than in East. The trioleine TAG (OOO) relative percentage was systematically higher in the Ugandan shea butters.

These results based on a large collection of samples, confirm the differentiation in fat shea nut composition due to geographical origins.

13:45-14:15 □ *Davrieux*, et al. "Near infrared spectroscopy for high-throughput characterization of shea tree nut fat profiles"

The Shea tree (*Vitellaria paradoxa*) is a major tree species in African agroforestry systems. Butter extracted from its nuts offers an opportunity for sustainable development in Sudanian countries and an attractive potential for the food and cosmetics industries. The purpose of this study was to develop near infrared spectroscopy (NIRS) calibrations to characterize Shea nut fat profiles. Powders prepared from nuts collected from 624 trees in five African countries (Senegal, Mali, Burkina Faso, Ghana and Uganda) were analyzed for moisture content, fat content using solvent extraction, and fatty acid profiles using gas chromatography.

A subset of 156 samples were analysed for free fatty acids (FFA) content. The FFA range was increased using 53 samples enriched by natural evolution during storage in climatic oven (28°C, 60%RH).

Results confirmed the differences between East and West African Shea nut fat composition: eastern nuts had significantly higher fat and oleic acid contents. Near infrared reflectance spectra were recorded for each sample. Ten percent of the samples were randomly selected for validation and the remaining samples used for calibration. For each constituent, calibration equations were developed using Modified Partial Least Squares (MPLS) regression. The equation performances were evaluated using the Ratio Performance to Deviation (RPD_p) and R_p^2 parameters, obtained by comparison of the validation set NIR predictions and corresponding laboratory values. Moisture (RPD_p=4.45; R_p^2=0.95) and fat (RPD_p=5.6; R_p^2=0.97) calibrations enabled accurate determination of these traits. NIR models for stearic (RPD_p=6.26; R_p^2=0.98) and oleic (RPD_p=7.91; R_p^2=0.99) acids were highly efficient, and enabled sharp characterization of these two major Shea butter fatty acids. High FFA samples obtained by incubation were beneficial for calibration set up, FFA calibration allowed accurate prediction of natural range of shea nuts FFA content (RPD_p=8.52, R^2_p=0,98).

This study demonstrated the ability of near-infrared spectroscopy for high-throughput phenotyping of Shea nuts. NIRS can be used for Shea nuts fat quality assessment. Transferring this technology to producing countries will enable high-throughput shea nut quality control and a traceability survey. Moreover, our NIR models make it possible to carry out further quantitative genetic investigations.

14:15-14:45 *Allal et al* "Fatty acid and tocopherol patterns of variation within the natural range of the shea tree (*Vitellaria paradoxa*)".

The shea tree, *Vitellaria paradoxa*, is one of the most economically and culturally important indigenous tree species in the Sudano-Sahelian region. Its seeds contain a vegetable fat, internationally known as shea butter, which is widely used in edible, cosmetic and pharmaceutical sectors.
Based on samples from 456 trees distributed in 17 locations across the species natural range from Senegal to Uganda, the fatty acid and tocopherol variation, and its relationship with geographic and climatic variables, was assessed in order to address the pattern and the origin of this variation across the natural range.
Significant differences between Western and Eastern regions for oleic, stearic acid, saturated-unsaturated acid ratio and γ-tocopherol were identified that it is postulated maybe a result of genetic drift due to the evolutionary history of shea tree populations.
Within regions the difference among stands was significant for most constituents; however the major part of the variation was observed among trees within stand (53-90 %). Relationships with climatic variables were not verified, weakening evidence for clinal variation hypotheses suggested by previous studies.

14:45-15:05 *Yidana et al.* "Free fatty acid content of sheabutter in Northern Ghana".

Shea butter is a vegetable fat extracted from shea nuts (the dried seed) of the fruits of the shea tree (*Vitellaria paradoxa*, Geartn) growing naturally in Africa. It is used locally as a cooking fat and in industry worldwide in the manufacture of chocolate and other confectionery, cosmetics and as a base in various pharmaceutical products. Shea nuts are produced by rural women whilst shea butter extraction is by women's cooperative groups in Urban Centres. Natural shea butter has low or no free fatty acid (ffa) content and attract premium prices from buyers. Shea butter with high ffa content (> 1 %) is rejected. This study investigated the ffa content of shea nuts and shea butter in the Tamale Metropolis and 10 other districts of the Northern Region of Ghana using the End Point Method (ASTM, 1974). The results showed a range of 0.18 % to 3.67 % in both shea nuts and shea butter collected from various producers. There was a strong positive correlation between the ffa of shea nuts and the shea butter they produced. It was concluded that the ffa content of sheabutter is primarily determined by the ffa content of the sheanuts used. An assessment of some local practices aimed at reducing the ffa content in sheabutter proved ineffective.

8:30-9:00 *Aly et al.* "Determination of geographical origin of shea tree fruits by using genetic fingerprints of the microbial community by PCR/DGGE"

The new European law on food safety, applicable since January 1st, 2005, obliges industry to trace their foodstuffs and assure the safety of the consumer.
The main objective of WP6 was to study some of the potential available analytical method based on different types of makers for origin determination. The objective of the WP6 is to encourage and promote traceability initiatives through innovative research on methodology.
Given the difficulty of setting up documentation systems in developing countries and particularly in countries of sub-Saharan Africa, new strategies of traceability are emerging. Among the new means of tracing products of plant origin, the idea of creating a "biological bar code" based on the analysis of DNA of microorganisms present on fruit was an interesting idea. This idea assumed that the commensal microflora (yeasts and molds) present on Shea fruit is linked to the geographical area of production. The first stage of this study was to explore the variability, reliability and robustness of PCR-DGGE. We showed that 2 fruits were the minimum number of samples sufficiently representative of the geographical origin. The main result of this study was that the electrophoretic profiles of DNA from yeasts and molds fruits extracted from Shea fruits, obtained by PCR-DGGE, were linked to the geographical origins of fruits. We proved that the environmental differences of the places where the fruits of Shea were harvested had a major effect on the ecology of yeasts and molds. The factor that had the most influence on the microbial content for a given geographic area was rainfall. The sensitivity of PCR-DGGE was 2.1×10^2 CFU/mL for yeasts and 10^3 spores/mL for molds. Yeasts and molds are then markers which are sustainable during the harvest season.
In all overview, we can say the WP6 had a very important role for achieving the objectives of the project whether in commercial or industrial fields.

26. oct

9:00-9:20 *Byakagaba et al.* "Fruit yield under different environmental conditions in Uganda".

Vitellaria paradoxa commonly known as Shea butter tree is one of the most dominant tree species in Savanna woodlands of Africa. It is an important tree species due to its significant ecological and socio-economic potential for livelihood improvement. The fruit pulp is edible, while the butter extracted from the dried kernels may be used for local consumption, manufacturing of cosmetics, pharmaceutical and confectionery industries. Despite shea butter products increasingly becoming popular at local and international level, there is lack of accurate data on fruit yield of shea butter trees. Spatial and temporal patterns of shea butter fruit production is yet to be well understood especially for subsp. *Nilotica*. The aim of this study was to assess *V. paradoxa* fruit yield in relation to dendrometric variables and selected environmental conditions in Uganda. We hypothesised that fruit yield is not influenced by dendrometric traits of the tree and environmental conditions. Four districts each representing the different regions of the Shea belt of Uganda were selected. One site was selected subjectively from each of the district based on the presence of fallows and current fields. Fallow land was further categorised as "old and young" depending on the duration under which it had been under fallow. Four plots of 50x50m were established along a transect in each of the land management categories. For two consecutive years fruit yield assessment of three randomly selected mature *V. paradoxa* in each of the 50x50m plots was carried out. Fruit yield was measured using randomised branch sampling. Total height, height at first branching, crown diameter and DBH of the selected trees were measured. Rainfall, humidity and temperature were recorded at each site for two consecutive years. Pearson correlation coefficient was used to determine the association between quantity of fruit and dendrometric traits of *V. paradoxa* under selected environmental conditions. Fruit yield was not influenced by size of the tree, height, height at first branching, crown diameter and number of branches at first point of branching. Young fallow had better fruit yield compared to old fallows and current fields. Fruit yield was low in the year with high annual rainfall compared to the year with less rainfall. Fruit yield in *Vitellaria paradoxa* is not influenced by dendrometric traits but rather rainfall and land management practices.

9:20-9:50 *Margout, et al* "Evaluating the suitability of different shea butters as raw material sources for cosmetic and pharmaceutical applications".

The evaluation of the composition of the various fractions of the kernel fats of the shea tree were determined for different samples from two origins East and West. Three samples of Mali (one native of M'Peresso, one of Wollodo and one corresponding to a blend of various Mali origin kernels) and one sample of Uganda. The general objective is to evaluate the suitability of shea butters and other derived materials from different locations to serve as raw materials for the development of high value added ingredients for skin care and cosmeceutical uses.

10:20-10:50 *Lovett* "The importance of good nuts – *sheanut harvesting, boiling and drying"*.

During the last decade, the importance of shea to the West African economy has increased dramatically as annual export volumes have approximately doubled from 150,000 to 300,000 SETs. More significantly, estimated revenue value has increased by over 1,000% as both nut prices – and value-added processing in the sub-region – increase. This in turn contributes to improved livelihoods for over 4 million women pickers across 3+ million km^2 of African Savannah-Sahel with a *regional income multiplier* for the sale of sheanuts in Mali estimated at 1.58. Hand-crafted-butter (HCB) exports also increasing – benefiting thousands of butter-processing women's livelihoods – Ghana alone is witnessing exponential growth in HCB shipments (5 t in 1994 to >1,000 t in 2010).
International buyers, however, prefer high and consistent oil quality because refining and processing losses are economic costs, e.g. 1.5% butter volume lost removing 1% free fatty acid (FFA). During stearin production, recovery yield reduced 1% per 1% sheanut FFA content. Both women and firms, who process shea, report >50% yield variations resulting from poor quality sheanuts, i.e., extraction efficiency ranges from below 40% to over 90% for best material. Improvement to shea quality will have significant economic impact to all involved in the shea value chain. Improved production economics will help cover costs of scaling up traceability efforts and help prove sustainability in the supply chain. For shea sector future growth, enhanced competitivity is critical, especially in a global oils and fats market, where ¾ of global vegetable oil, is from just four intensively managed species (palm, canola, soya and sunflower oil production = 127 million tons).

Research ongoing over the last decade indicates that addressing post-harvest processing is the key to improving quality in the region, for example, to minimise FFA levels:

1. Collect ripe, fallen fruit quickly before the recalcitrant seeds germinate
2. Immerse for 20-40 minutes in boiling water, as soon as possible
3. Dry efficiently (avoid precipitation) on clean surfaces free of silica-rich dust and animal waste
4. Drying racks or poly-tunnels offer highest quality opportunity, but economics challenge

The other critical issue needing immediate recognition is that sheanut production and trade are where development solutions need applying. It has been said that there is a **Paradox of *paradoxa***: *90% of knowledge available to market is about hand-crafted shea butter, but, 90% of actual trade is in nuts*. Whether shea is an ingredient in chocolate or body butters, the source is invisible to consumers and so does the plight of the parklands and millions of rural African women.

10:50-11:10 □ *Vind & Lovett*, "Boiling freshly harvested shea nuts and its effect on shea butter quality".

The shea tree, *Vitellaria paradoxa* C.F. Gaertn, is a species of socio-economic interest for the Sudano-Sahelzone of Sub-Saharan Africa. During the last decade, export importance of shea butter has increased significantly, as in turn, has its contribution to shea nut-processing women's livelihoods. International buyers demand high and uniform oil quality. It is therefore important to ensure quality control at village processing level. Buyers expect low levels of free fatty acids, and peroxide values, and high levels of unsaponifiable matter, which few African producers and exporters can meet effectively. Once women have collected the fallen fruit (during the rainy season between May-August in northern Ghana), traditional processing includes boiling of shea nuts prior to sun-drying. Previous research suggests the rationale for boiling is to denature lipases preventing FFA to form as a result of enzyme-catalysed hydrolysis. From the testing of simple boiling equipment at village level, this study offers evidence, on the effect of boiling time on FFA, PV, unsaps and shea butter yield. The study demonstrates that boiling is important for FFA formation but insignificant for yield, peroxide value and unsaponifiable content, offering opportunities to reduce time, firewood use and carbon footprint of shea nut.

11:10-11:30 □ *Odongo et al* "Marketing and Trade Patterns for Shea Nut Productions in Uganda".

An assessment of the marketing and trade patterns of shea nut products in Uganda was undertaken between May 2008 and April 2009 in Katakwi, Lira, Pader, Kitgum, Moyo and Arua districts Uganda. A structured questionnaire was used to collect data from 140 shea nut gatherers and shea oil producers. SPSS was used for descriptive analysis while STATA was used to analyze the factors affecting market participation amongst shea nuts producing households. Results show that, shea nut producers are resource poor women with low levels of education. To these women, shea business is a safety net to meet their subsistence needs. The most commercialized shea product in the national market is shea nuts. There was a high degree of vertical integration in shea market where the governance structure is characterized by close coordination. The major barriers to entry in the national and international markets for Uganda shea products are the quality of the shea nuts, while the critical factors for successful commercialization of shea products are price and improved quality through product differentiation and branding. Heckman's two-stage results shows that the price of shea nuts is the major factor affecting the decision to participate in shea nut marketing while training, distance to markets, lack of organisation for collective action and low household income significantly influence the extent of market participation. There is thus a need for policy interventions geared towards improving the market infrastructure in the shea zone and conservation of the shea trees from destructive uses. Shea producers need to be organized into shea producers/processors associations which can train farmers on shea nut gathering, processing, marketing and certification in order to improve the marketable attributes of shea nuts. There is a need to improve the quality of Ugandan shea products through product differentiation, branding and certification so as to attract higher prices for Uganda's shea products.

11:30-12:00 *Kerchove et al* "Governance and upgrading of shea value-chains: experiences from country cases studies and global value chain mapping ".

The global Shea value chains have been subject to numerous research activities and studies in recent years. These studies generated highly valuable results and in their majority recommended the further analysis of value chain upgrading opportunities and better integration of local actors into the international value chains. The INNOVKAR research project has acknowledged the work of scientists and NGOs that have conducted this research. Consequently, the workpackage on marketing and value chain analysis focused on aspects in continuation of the research results of the past.
The presentation will highlight INNOVKAR research results on governance and upgrading in Shea value chains. It starts with a brief overview of state of Shea value chains in producing countries (Burkina Faso, Mali, Senegal, Ghana and Uganda), based on results of INNOVKAR country case studies conducted in 2008/2009. Further, results will be presented from the global mapping of Shea buyers and international trade flows, which has been realized in 2009 and comprised a survey of more than 150 Shea buying and processing companies worldwide. This information is setting the stage for presentation of the results of two studies that have been conducted in Mali and Ghana in 2010. The studies indicate how governance in Shea value chains can be described and where upgrading approaches have worked out.

13:30-13:50 *Okullo et al.* "Challenges to and opportunities for sustainable utilisation of shea in Uganda".

An assessment of challenges to and opportunities for sustainable utilization of the shea tree (*V. paradoxa*) was carried out in Uganda between 2007 and 2010. Data were collected using questionnaire, focused group discussions and key informant interviews and analysed using SPSS. Results indicate that the tree currently is entirely a wild resource with great economic potential. Over 90% of the respondents reported that shea products are highly valued as source of edible oil and also sold in local markets as edible fruits, building materials, firewood and charcoal for income. The major traditional tree management strategies in the shea parkland included protecting naturally regenerating individuals when opening farmlands, weeding, staking seedlings, early burning, use of taboos/bye-laws and discouraging other farmers from cutting down trees growing on their farmlands. Persistent insecurity, internal displacement and a high demand of the species for fuel wood have threatened its conservation. This has led to more mature shea trees being cut for charcoal that are also sold to earn cash for meeting the basic household needs. Other conservation challenges included tree and land tenure system, termite attacks, lack of shea tree planting materials and high level of poverty in the area. To enhance conservation of *V. paradoxa*, community mobilisation, appropriate extension programmes, provision of market information, development of appropriate vegetative propagation methods and value addition are essential. Local communities' involvement in executing interventions such as assisted tree regeneration coupled with protecting and stimulating the growth of naturally regenerating indigenous trees are a prerequisite in the area.

13:50-14:20 *Lovett* "Linking quality, conservation and revenue – *Hippo Shea"*.

The Savannah Fruits Company Ltd (SFC), National Conservation Resource Centre (NCRC) and the Sanctuary Management Board (SMB) of Wechiau Community Hippo Sanctuary (WCHS) have agreement covering collaboration relating to sustainable sourcing of shea butter from *Vitellaria paradoxa* subsp. *paradoxa*, Common Hippo (*Hippopotamus amphibious*) conservation in the Wechiau Sanctuary, Ghana, and associated activities.
SFC has been sourcing organically certified sheanuts from WCHS for the last few years and it is expected organic shea butter production will start in Wechiau in 2012. In addition to improved market access and increased payments from organic premiums for the women shea collectors, SFC pays premiums into *The Wechiau Sanctuary Conservation Trust Fund*, established by NCRC and SMB. All parties agree that *third-party proof* of this sustainable system, and development of a suitable brand or label, has the potential to improve consumer recognition of, and confidence in, the existing supply chain in order to achieve the following:

- Increase sales of sustainably sourced / certified organic *Hippo Shea*
- Provide increased revenue to assist improve the livelihoods of the women of WCHS
- Provide increased revenue for sustainable conservation activities in WCHS

This presentation will describe eco-labelling examples to illustrate the key attributes that the *Hippo Shea* brand should possesses. Then using this model, describe how *green* brands can link shea quality improvement, sustainable parkland management and increased community benefits following certification and commercialisation of butter production linked to conservation of these remarkable, yet vulnerable, aquatic mammals of the Black Volta in northern Ghana.