Abstract
An assessment of sustainable oil palm production was conducted in the Amansie West District of the Ashanti Region, Ghana. The study assessed practices that will ensure good productivity of oil palm in the face of climate change and climate variability, determine the socio-economic circumstances of targeted oil palm farmers, determine the genuineness of oil palm planting material and make appropriate recommendations that will lead to sustainable oil palm production. The area was selected due to its relatively high poverty and predominant illegal mining activities. Information was collected through detailed field inspection of farms, focus group discussion and key informant interviews, soil sampling and laboratory analysis. Additionally, fruits were randomly sampled to determine fruit types. The study revealed a mixture of dura, tenera and pisifera planting materials in all selected fields/plantations, an indication that planting materials were not purchased from accredited sources. Square planting pattern, unpruned and excessive pruning and shading of palms show low technical know-how of extension agents and farmers on oil palm cultivation. Low soil fertility and relatively high water deficit in the area is a concern to climate scientists in this study. For sustainable oil palm production in the study area, it is recommended that: 1) Planting materials are purchased from accredited source. 2) Millenium Village Project (MVP) should assist farmers to replant fields with recommended distance and with correct planting orientation. 3) MVP should assist farmers to set up nurseries in strategic locations with certified planting materials. 4) Farmers are trained on sustainable oil palm production with emphasis on soil moisture conservation techniques in the face of current climate change and climate variability.

Introduction
The Oil palm (Elaeis guineensis Jacq.), originated in the tropical rain forest region of West Africa (Sowunmi, 1999). The main oil palm belt runs through Côte d’Ivoire, Ghana, Liberia, Nigeria, Sierra Leone, and Togo and into the southern latitudes of Cameroon, the equatorial region of Angola and the Democratic Republic of Congo. The crop has been determined by the government of Ghana as one of the important cash crops that can enhance economic growth (PSI-Oil Palm Report, 2003). Currently it contributes about 1% of the country’s Gross Domestic Product (GDP) (MASDAR, 2011). The crop therefore, is a good candidate for the attainment of the Sustainable Development Goals (SDGs) one (1) and two (2) which seeks to eradicate poverty and hunger by 2030. In Ghana, the consumption of palm oil and derived products is expected to increase as the population grows. Strong demand for vegetable oil in Ghana has resulted in the expansion of the oil palm sector. This has important economic impact because of provision of employment.

In addition, palm oil is now a major source of income and trade along border districts (Ofosu-Budu & Sarpong, 2013). However, the yield of Fresh Fruit Bunches (FFB) in Ghana is poor and has decreased from 6.5 tons per ha per year in 1990 to 5.4 tons per ha per year in 2012 (FAO, 2014). By contrast, FFB yields in the major producing countries in Southeast Asia and Latin America are more than three times greater at 18.5–19.0 tons per ha per year (FAO, 2014). Among other factors such as the use of uncertified planting materials, low yield may be attributed to limited experience and knowledge in intensifying yields through improved agronomic and phytosanitary practices.

Nevertheless, the current low yield of palms is also exacerbated by current climate change and variability. In Ghana, Danso et al. (2008) found an inverse relationship between FFB yield and water deficit. They concluded that dry spells/drought contribute to poor growth and yield of oil palm.

Assessing the environmental conditions and management practices under which oil palm is cultivated will serve as a support to increase oil palm production. It has been hypothesized that healthy plants not excluding oil palm are more robust and resilient to climate change and variability. Working with crop growth simulation models and climate models in three countries in the Sudan Savanna of West Africa, Danso (2015) projected that by 2050, crops that are cultivated under good management practices would be more climate resilient than their counterparts without good management practices.

The area was selected due to its relatively high poverty and predominant illegal mining activities (galamsey) of the populations and Millennium Villages Project (MVP) which is an integrated development initiative with a holistic package of interventions to lift communities in the Amansie West District out of extreme hunger and poverty to meet the Sustainable
Development Goals (SGDs) sees oil palm cultivation as alternate means of livelihood to community members who are mainly small scale illegal miners (galamsay operators). Therefore this study which was undertaken in the Amansie West District of Ashanti Region, Ghana sought to:

1. Describe the socio-economic circumstance of oil palm farming communities;
2. assess the various agronomic management practices and phytosanitary conditions that will ensure healthy production of oil palm in the face of current climate change and variability;
3. assess genuineness of oil palm planting material engaged in the establishment of targeted smallholder farms; and
4. recommend appropriate strategies and interventions that would lead to sustainable production of oil palm.

Materials and Methods

The study took place in five (5) smallholder oil palm plantations in the MVP (Millennium Villages Project) Bonsaaso Cluster (Figure 1) in the Amansie West District of Ashanti Region. The MVP is an integrated development initiative to lift communities in the Amansie West District who are mostly illegal small scale miners out of extreme hunger and poverty to meet the Sustainable Development Goals (SGDs). Through its innovative strategies and interventions, the MVP Bonsaaso Cluster rehabilitates existing oil palm farms with the objective to mainstream oil palm as an income generating value chain. The methods employed during the study were:

Field observation and interviews
Fields were visited to observe planting orientation of palms, planting distance and the maintenance practices on the farms. Field inspection also covered pest and disease infestations. There were interviews and Focus Group Discussions (FDGs) with project staff, Agricultural Extension Agents and farmers during the field visits.

Benchmark soil identification and classification
Classification and identification of the soils in the project area was based on the Ghana Interim soil classification system (Brammer & Charter, 1962). The classification and identification system uses a combination of the expression and intensity of morphological, physical and chemical properties of the soils to put them in appropriate taxa.

Determination of existence of underlying hardpan
Hardpan is underlying rock that hampers the growth of plants. Sampling spots/pits were dug to observe the presence or absence of hardpan at the upland and lowlands (Figure 2). The pits were dug down to a depth of 100 cm for hard pan observation.

Soil sampling and analysis
Collection of soil samples for laboratory analysis
Soils were sampled from both palm rings and inter-rows at upland and lowlands of the plantations/farms. About fifty (50) spots (ten spots from each farm) were sampled from five (5) oil palm plantations at a depth of 0–15cm and 15–30 cm soil depths (Figure 3). Samples within a soil depth were bulked together. The samples were air-dried for 24 hours, crushed in a mortar with pestle and sieved through a 2 mm sieve. The composite samples were analysed in the laboratory. The following parameters were determined:

- Soil pH in a 1:1 suspension of soil and water using a H1 9017 microprocessor pH meter.
- Organic matter by a modified Walkley and Black procedure as described by Nelson & Sommers (1982).
- Total nitrogen (N): by the Kjeldahl digestion and distillation procedure as described in Soil Laboratory Staff (1984).
Exchangeable bases (calcium, magnesium, potassium and sodium): in 1.0 M ammonium acetate (NH4OAc) extract (Black, 1986).

Exchangeable acidity (hydrogen and aluminum) in 1.0 M KCl extract as described by Page et al. (1982).

Calcium and magnesium in the extract were determined by EDTA titration. Potassium and sodium in the extract were determined by flame photometry.

Effective cation exchange capacity (ECEC) was determined by the sum of exchangeable bases (calcium, magnesium, sodium and potassium) and exchangeable acidity (aluminum and hydrogen).

Available phosphorus (P) was determined by the Bray–1 method as described by Bray & Kurtz (1945). Particle size distribution was determined by the hydrometer method.

Texture (sand, silt and clay) was determined by the hydrometer method as described by Bouyoucos (1962).

C:N ratio was calculated from the soil analysis results by relating organic C values to total N.

Annual water deficit determination
Collection of climatic data (rainfall, temperature, relative humidity) for analysis and interpretation. Rainfall data (from 1990 to 2010) was collected from the Meteorological Service Department in the district. Monthly and annual water deficits which are very important factors influencing yield, were calculated from the rainfall data using the formula:

\[ D = R + P - Pe \]  \hspace{1cm} (1)

Where: \( D \) = Water deficits; \( R \) = Theoretical soil moisture reserve at the end of the previous month; \( P \) = precipitation or rainfall for the month; \( Pe \) = potential evapotranspiration for the rainfall month (Surre, 1968).

Determination of planting material type in the farms
Fruits were collected from five (5) farms out of the seven (7) farms visited for detailed study of planting material type used in cultivation. Ten (10) palm trees were randomly chosen from each farm. For each palm, four (4) fruits were sampled resulting in a total of forty (40) fruits from a farm. A sharp knife was used to cut through the transverse and the longitudinal sections of fruits. Fruits were identified and classified into either tenera, dura or pisifera.

Key informant interview and Focus Group Discussion
One key informant, (a sub chief, who is also an oil palm farmer), was selected for detailed interview on the production practices of oil palm and type of planting material used. The interview also covered the socio-economic impact of oil palm cultivation on the livelihood of farmers in the area. Two Focus Group Discussions were held with Agricultural Extension Agents, farmers and facilitators of the MVP project. A check list (Swanzy, 2010) was used to guide and direct the interview to obtain the right information. A total number of 5 AEs and 8 farmers were involved in the Focus Group Discussions.

Results and discussion
Type of planting materials
The success of the oil palm industry depends much on the type of planting material that is used in cultivation. The variability checks on five farms visited are shown in Table 1. The variability in the fruit types (Figure 4 to 6) on the farms sampled clearly showed a variation in fruit types. This implies that the planting materials used in establishing the farms were not from an accredited (certified) source. The tenera (Figure 5) which is a cross between the dura and pisifera palms is the recommended planting material for commercial oil palm production. It has a relatively large mesocarp for palm oil extraction, a thin shell and a kernel for kernel oil production (CSIR-OPRI, 2014). The CSIR-Oil Palm Research Institute makes crosses under controlled pollination conditions to produce 100% tenera seeds for commercial plantation development. This is what is certified and recommended for planting in Ghana.

Segregation of oil palm in studied area
The oil palm seeds from the study area come from tenera x tenera crosses segregate on the field thus giving 25% sterile pisiferas, 50% teneras and 25% thick-shelled duras with very
poor oil content leading to economic losses. Hence, farmers have to always obtain seeds from certified seed producer (CSIR-Oil Palm Research Institute, Kade, Ghana Oil Palm Development Company-GOPDC etc.).

**Climatic conditions**

**Rainfall pattern**

The rainfall pattern in the project site is bi-modal (Figure 8). This pattern is characteristic of oil palm growing areas in the country. The mean annual rainfall for the period 1999-2009 was 1504.81 mm. The major rainfall season begins from March to July whilst the minor season starts from September to November. A comparison of the rainfall regime of Kusi (optimum oil palm growing zone in Ghana) and Bonsaaso cluster from 1999-2009 (Figure 9) showed that the rainfall pattern in the 2 locations followed a similar pattern (bimodal). The maximum (2213 mm) and minimum (1032 mm) rainfall figures in Bonsaaso cluster were however lower than that at Kusi (2463 mm and 1152.0 mm respectively).
Soil Conditions at Bonsaaso MVP Cluster
Table 2 provides the soil fertility parameters and the soil physical properties of the study area

Table 2. Chemical and physical properties of the soil in the study area

<table>
<thead>
<tr>
<th>Soil depth (cm)</th>
<th>0 - 15</th>
<th>15 - 30</th>
<th>Crit. Val(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH (1:2.5 H2O)</td>
<td>5.06</td>
<td>4.9</td>
<td>5.5-6.0</td>
</tr>
<tr>
<td>Org. Carbon (%)</td>
<td>0.94</td>
<td>0.87</td>
<td>-</td>
</tr>
<tr>
<td>Organic matter (%)</td>
<td>1.87</td>
<td>1.49</td>
<td>3</td>
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<tr>
<td>Total N (%)</td>
<td>0.1</td>
<td>0.07</td>
<td>&gt;0.2</td>
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Available Bray’s (mg/kg)

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<tr>
<td>P</td>
<td>3.87</td>
<td>2.23</td>
<td>&gt;10</td>
</tr>
<tr>
<td>K</td>
<td>68.07</td>
<td>58.03</td>
<td>&gt;50</td>
</tr>
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Exchangeable bases (cmol/kg)

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<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Mg</td>
<td>1.2</td>
<td>0.87</td>
<td>&gt;4</td>
</tr>
<tr>
<td>K</td>
<td>0.15</td>
<td>1.14</td>
<td>&gt;0.25</td>
</tr>
<tr>
<td>Na</td>
<td>0.07</td>
<td>0.09</td>
<td>&gt;0.3</td>
</tr>
<tr>
<td>Ca</td>
<td>3.12</td>
<td>2.45</td>
<td>&gt;10</td>
</tr>
<tr>
<td>TEB</td>
<td>4.54</td>
<td>3.54</td>
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Exchangeable acidity (cmol/kg)

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<tr>
<td>Mg</td>
<td>0.77</td>
<td>0.08</td>
</tr>
<tr>
<td>ECEC (cmol/kg)</td>
<td>9.97</td>
<td>4.35</td>
</tr>
<tr>
<td>Base saturation (%)</td>
<td>83.12</td>
<td>78.8</td>
</tr>
<tr>
<td>Particle size (%)</td>
<td></td>
<td>&gt;70</td>
</tr>
</tbody>
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Soil Conditions at Bonsaaso MVP Cluster

The low pH values of the soils were similar to those reported for some Ghanaian soils by Adu & Tenadu (1979). Strong leaching of the basic cations out of the top soil contributed to the low pH values. It is expected that this factor will affect the dynamics of all nutrients and especially phosphate because the available P depends to a large extent on interactions with constituents carrying a variable charge (Quang et al., 1996). The very low organic carbon content and low exchangeable bases particularly calcium reflected the generally high weathered soils in the humid rainforest agro-ecological zone of the country (Owusu-Bennoah et al., 2000). This property of the soil is attributed mainly to the excessive leaching of the soils caused by rainfall and constant plant nutrient uptake by the crops without replenishment. The low ECEC values could be attributed to the low organic matter and to the fact that the clay fraction is dominated by low activity clays (kaolinitic) (Owusu-Bennoah et al., 2000). The high build up of available K in the 15–30 cm depth could be attributed to movement of K minerals due to leaching. The available P content indicated that the soil is extremely low in P. According to Hartley (1988), the threshold deficiency for P is 10 mg/kg. This could be attributed to the advanced stage of weathering of the parent rocks which lacked primary weatherable minerals necessary for nutrient recharge (Charreau, 1974). The nutrient status of the soils in the various farms needs to be improved with the required amounts of recommended fertilizers (organic and inorganic).

Benchmark soils identified at the study area

Soils in the area could be categorized under six main compound associations. About ten soil series exist under these compound associations. The soil series which are classified based on the Ghana Interim Soil Classification System (Brammer & Charter, 1962) consist of: Bekwai series, Nzema series, Oda series, Kakum series, Kokofu series, Eschien series, Kobeda series, Mim series, Amun series and Temang series. The range of soil series recorded in the area indicates the presence of a typical catena cutting across the terrain in the district. The Bekwai and the Nzima soil series occupy about 70% of the district. These soils with the characteristics of being deep, well drained loam to clay loam with less concretion have the potential of supporting the growth of oil palm. The Nzima soil series is very common in optimum oil palm growing areas in Ghana such as Kusi in the Eastern region of Ghana (Asamoah & Nuertey, 2005).

State of selected oil palm farms

Planting pattern

The square planting pattern with varying distances was observed on all the farms visited. This planting pattern does not conform to the agronomically acceptable standards in oil palm cultivation. The high planting density in a square planting pattern observed in some farms has led to competition for basic oil palm requirements. As a result some palms were seen to have grown tall and etiolated. On the other hand, a sparse planting density (evident in some farms) is a waste of land resources. For good growth and productivity, the optimum spacing for oil palm is 8.8 m triangular (148 palms per ha) and aligned to the North-South line.

Sanitation

The maintenance regime (weeding, pruning) on most of the farms visited was generally poor. Pruning had not been well done in the few cases where the practice (pruning) had been attempted. There were cases of excessive pruning which tended to affect the architecture of the palms. An instance of fronds supporting developing bunches being cut was observed. None of the farms had been planted with cover crops and there were no harvesting paths.
Shading
The oil palm is a sun-loving crop and shading of palms will significantly reduce yield. Tall trees had been left standing in some farms visited. These together with left over stumps which had been left to rejuvenate in some of the farms cause shading which tends to adversely affect production (Figure 11).

Pruning
Farms were either pruned excessively or not pruned at all (Figures 12 to 14). Excessive pruning reduces the photosynthetic area of palms. As a result more male inflorescences are produced at the expense of the female inflorescences and this eventually reduces yield of fresh fruit bunches. Pruning is a very important field management practice in oil palm cultivation as it helps to remove non-functional/desiccated fronds which obstructs harvesting and also prevents farmers from detecting ripe palm fruits. Some pocket prunes (Figure 12) were noticed on some palms. These pockets normally occur as a result of the use of wrong tools for pruning. The pocket prunes reduce the quantity of loose fruits through trapping in the pockets.

Insect pests and diseases
Insects
There were symptoms (indicating the presence) of the African spear borer *Pimilephila ghesqueiri* (*Lepidoptera: Pyrithidae*) and the Rhinoceros beetle (*Coleoptera: Hystidae*) on the farms visited. No economic damage could however be attributed to the presence of the insects. The red ant, *Oecophylla longinoda* was frequently observed on the fronds of the oil palm on most of the farms visited.

Diseases
No disease of economic importance to the oil palm was observed on the farms visited. The rottening of the bunches observed could not directly be attributed to disease causing organisms. There were however isolated cases of whitish substance/growth on some bunches. When the whitish growth was removed, it was observed the fruits on the bunches were rotten.

Socio-economic conditions in the Bonsaaso cluster
Food Culture of the area
The staple food crops of the area are mostly cassava, maize and plantain. This pattern follows the nature of meals taken by the people. The predominant meal that features almost
every day in most households is pounded boiled cassava. Oil palm and its products form a major part of foods in the area. However, food crop production is done on a small-scale due to the small-scale artisanal mining and preference for cocoa production by the people. Thus, there is food scarcity in the area (key informant interview). This situation compels the people to travel to nearby city (Kumasi) to buy food items. The food situation will call for education of farmers to adopt an economically sustainable and efficient oil palm-food crop intercropping technologies developed by the CSIR-OPRI at least for the first three years of oil palm establishment.

**Existing knowledge and skills of farmers and Agricultural Extension Agents (AEAs) on oil palm Best Management Practices (BMP)**

Through the focus group discussion the farmers indicated that they have low level of knowledge and skill with regards to oil palm production. The AEAs they consult mostly give them information on cocoa production rather than oil palm. This situation is manifested in the poor farming practices such as use of uncertified planting materials and improper planting patterns used by the farmers to cultivate the oil palm. The AEAs confirmed the farmers’ assertion of low knowledge and skills as the AEAS indicated that they do not have training in oil palm cultivation hence they only provide the little information in terms of planting distance and orientation of palms, use of wire collars. This situation could have contributed to the square planting observed. Hardjono et al. (2003) and Fromm, 2007 reported poor extension service, insufficient human capability and lack of relevant institutions resulted in poor adoption of oil production and processing practices in Indonesia.

**Other economic activities that may compete with oil palm production**

Small scale mining and/or unorganized mining (galamsey) is predominant in the area. There will be stiff competition for labour and possibly destruction of oil palm farms if tenurial arrangements are not properly made. Cocoa production is also active in the area. Currently more time and resources are devoted to cocoa by the farmers than to oil palm.

**Rural Infrastructure and innovation that will promote oil palm production**

The rural road network in the cluster is currently undergoing rehabilitation and upgrading. The road network and bridge building projects will greatly improve farmers’ access to farm inputs and AEAs can easily visit their operational communities for extension activities. In addition, farmers can get easy access to markets through organized buyers at the farm gate. The quick carting of fruits to mills is very important to prevent fruit rottning which culminates in poor quality oil with high Free Fatty Acids (FFA), which is a common problem with artisanal palm oil processing in Ghana (Osei-Amponsah et al., 2012). The processing methods which include manual removal of the fruits, which takes several days and also damage lots of fruits, contribute greatly to fatty acid build-up.

The provision of good health facilities with well-equipped laboratories will reduce disease occurrences to enable farmers concentrate on their farm business. Innovations like metered solar energy systems, improved cook stoves, and cell-phone based information technology will provide better services and new opportunities that will arise as a result of active oil palm industry in the Cluster.

Furthermore, the team observed that fifteen communities in the cluster had access to potable water and sanitation. The social relationships such as farmers’ co-operatives and other farmer based organizations existing in the cluster should be properly organized to access farm credits, to market their farm products and also get regular training. These farmer groups can in the long run be turned into strong producer organizations for increased productivity. The land tenure systems observed were sharecropping, ownership by inheritance and lease. The land tenure arrangements should be formalized and documented to ensure security for the tenant farmers and also to prevent disputes that may disrupt the implementation of the project.

**Marketing and processing avenues**

Prominent among the issues raised by the farmers is lack of market to sell the palm fruits. Adjei-Nsiah et al. 2012 reported that small scale palm oil processors in the Kweabibirem District face serious marketing challenges, especially during the peak season of February-May. In addition, there are no mills, either small or large scale to process the palm fruits into palm oils.

**Conclusion and Recommendation**

Most farms were found to have been planted with uncertified planting materials. To ensure sustainable production and yields, the farms should be replanted with assistance from MVP with proven certified planting materials recommended by the CSIR – Oil Palm Research Institute. Under the assistantship of MVP, the present oil palm stands need to be replanted with proper orientation and at the recommended distances to avoid mutual shading for proper growth and development of the palms.

To facilitate the supply of high yielding planting materials, farmer groups should implement the decision to establish and maintain oil palm nurseries in the strategic locations within the cluster.

In the face of current climate change and climate variability, the erratic rainfall and relatively high water deficit in the Bonsaaso Cluster calls for the adoption of the appropriate agro-management measures to conserve moisture. These may include the construction of conservation pits, establishment of cover crops and mulching of palms with composted empty fruit bunches.

Almost all the areas sampled had pH levels below 5.0. The values are extremely acidic and calls for rock phosphate incorporation into the soil when plantations are established to raise the pH by at least 1 unit. Rock phosphate incorporation will
also improve calcium and low phosphorus content of soils of Bonsaaso cluster. The MVP should establish a processing mill for timely processing of Fresh Fruit Bunches.

Farmers and Agricultural Extension Agents in the cluster should be trained by CSIR – Oil Palm Research Institute on both nursery establishments and on oil palm field management practices.

**Good agricultural practices**

**Cover cropping:** Proper plantation development begins with the establishment of leguminous cover plants (LCP) immediately following land clearing. The LCP helps prevent soil erosion, control weeds, surface run-off, improve soil structure and palm root development. They also help to prevent outbreak of the Oryctes beetle and has the potential of incorporating approximately 200 kgN/ha/yr.

**Weed control:** Weeds were seen competing with palms for resources in all the farms visited. Gray and Hew (1968) reported yield losses of 6–20% in matured oil palms due to weed infestation. To reduce yield losses and for sustainable production, effective/regular weed control is essential.

**Harvesting:** Harvesting needs much time and much care, because only bunches which are cut at the right moment (ripeness) yield good-quality oil. The recommended ripening index is when the fruits begin to turn red, and when 2 fruits drop to the ground.

**Harvesting paths:** Harvesting paths are necessary within the interrows to facilitate harvesting, weed control, fertilization and other agronomic practices.

**Pruning:** Pruning is a very important field management practice in oil palm cultivation as it helps to remove non-functional/desiccated fronds which obstructs harvesting and also prevents farmers from detecting ripe palm fruits.

**Fertilization:** The natural nutrient supply of any soil is only of limited capacity. The oil palm is a heavy feeder crop and therefore extra supply of nutrients is always necessary. It is important to apply adequate and appropriate amounts of NPK and Mg for better and sustainable production (Ibrahim et al., 2001). Research results from CSIR-OPRI indicate an increase in yield of about 20–30% when plantations are fertilized.

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**References**


FAO (2014). *FAOSTAT Database*.


