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RESEARCH ARTICLE

MODELLING FIELD WORKABLE DAYS ON FERRALSOLS IN CAMEROON

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Abstract

The absence of accurate field operation time records may result to wasteful use of the time available for farm operation which reduces the possibility of a successful operation. Making decisions related to whether or not the soil is suitable for farm activities is essential. However, about 70% of Cameroon's soils are ferralsols and there is little to no data on how they respond to pressure from farm machinery intensities at different levels of moisture content. For the Bimodal Humid Forest Agroecological Zone of Cameroon, a model was developed to estimate soil suitability and the effective time available for farm operations on ferralsols. To achieve this goal, pot and field experiments were carried out to observed how bulk densities changes under different traffic intensities at various soil moisture levels. Also, NetBeans Integrated Development Environment (IDE) was used to develop a model in JAVA language that isran by a desktop. It was found that ferralsols have four main types of soil texture: Sandy Clay Loam, Clay, Sandy Clay, Clay Loam. Also, compaction caused by farm machinery traffic in these soils at depths of 0-15 cm tends to be greater than that at depths of 15-40 cm, which did not vary much; moisture content at wilting point (MCWP) was found to be between 10% and 15%, and critical moisture content (CMC) ranged from 25.88% to 38.32%. Furthermore, ferralsols reach their optimum bulk density at moisture contents higher than field capacity. The NGUTRACT model developed permits to determine if a day was workable or not based on several variables and consequently permit to determine the number of days in a year. As a result, the model is site-specific, and depending on the soil type and moisture content, a day may be workable for one farmer while being non-workable for another in the same location. However, in order to provide a comprehensive picture of the entire agroecological zone, the results should be extended to the East and South regions. NGUTRACT should be used in conjunction.

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Introduction:-

Soil compaction reduces infiltration rates at all scales, leading to increased runoff and can impact crop growth. The composition of the soil is critical for the healthy development of plants. It must thus, be porous and aerated to allow for the infiltration of agricultural water and water-soluble inputs, in addition to facilitating easy root development. Unfortunately, this is not always the case for all soils, because improper agricultural machinery use can further compact the soil. Soil compaction affects the physical properties of soil by increasing strength and bulk density, decreasing porosity, and forcing a smaller distribution of pore sizes within the soil (DuPont, 2012).

Reduced root growth and plant development are the agronomic consequences of soil compaction which leads to a decrease in crop output (Hakansson and Lipiec, 2000). According to Hakansson (1966), compaction can last for a long time and threatens the soil's long-term productivity, which is especially true in countries where agriculture is the primary industry, such as Cameroon.

Nature forces man to live in specific climate zones that also happen to be the best for agriculture (Raghavan et al., 1990). However, as a result of diminishing land and labor resources, rising food demand, and increased input costs, science and technology have been under pressure to increase the productivity of current agricultural soil and the efficiency of agricultural production.

According to Ratajet *et al.* (2014), large, powerful machinery degrades soil and its properties. Tillage operations are very difficult because of the use of ineffective agricultural tools like hoes and cutlasses and the presence of heavier soils that provide more resistance in the farming zone. So, using a tractor and a tillage tool is an essential alternative that enables farmers to increase their output. Sadly, if tractors are used on the soil continuously, the soil's relative level of compaction rises and, if the process is not controlled, eventually leads to hardpan.

Farmers assert that tillage, which is frequently used to remove soil ruts, can manage soil compaction. Thus, they become careless and disregard soil moisture conditions for traffic and other essential aspects of preventing soil compaction because assuming that tillage will always solve the problem (Tijink *et al.*, 1993).

Some countries develop agricultural policies with the goal of increasing the use of farm machinery in order to achieve food security and sovereignty. These strategies are intended to increase the influx of farm machines and their interventions in order to dramatically increase agricultural land surfaces and, as a result, production and productivity. Agricultural fields might very well face greater challenges in this regard than in the past.

In the case of Cameroon, in addition to the facilities established by the Government to enhance the purchase of farming equipment, Cameroon and India signed a convention on April 20, 2009, for the importation of 1,000 tractors with implements for Cameroonian farmers. (Ntap, 2018).

Thanks to this convention, the tractors were successfully imported and distributed to various parties. The development of hardpans may now have more opportunities as a result of the increased tractor traffic intensities in fields regarding this project's goal is to intensify agriculture. Cameroonian farmers need to be more aware about soil compaction now than in the past.

Several thousand years, according to various estimates, is the time required to create fertile soil (Zabrodskyi *et al.*, 2021) and numerous conditions must be met for soil to form. These authors came to the conclusion that under such conditions, the soil is not a renewable resource and that maintaining soil productivity is both morally and financially beneficial.

Given that ferralsols constitute nearly 70% of Cameroon's soils, understanding how these soils react to compaction may aid in reducing any potential negative effects on the overall amount of arable land as well as preventing severe environmental damage.

In order to ensure the success of the operations, majority of agricultural operations rely on timely application while respecting the weather. Every crop has an ideal time period for clearing, plowing, planting, weeding, harvesting, and post-harvest operations to achieve maximum crop yields at the lowest cost of inputs (labor, planting materials, machinery, soil, etc.). Due to the fact that some days within the corresponding periods will not be suitable for field operations, the ideal time spectrum for each agricultural operation is further constrained in practice. For instance,

Soil texture determination

Despite the fact that ferralsols constitute 70% of the soil type in the Bimodal Humid Forest Agroecological Zone of Cameroon, the soil exhibits patterns in the texture which can behave differently under compaction. In this regard the soil texture for ferralsols was assessed.

The tractor density and farm activities in the areas were used as the criteria for selecting research sites. The information was obtained from the local data base of tractors at the Ministry of Agriculture and Rural Development, at the Sub Department of Agricultural Mechanization (SDMA) and at the National Center of Studies and Experimentation on Agricultural Mechanization (CENEEMA). The selected sites (Table 1) were found to have structures that possess important farm machineries and some offering mechanization services within the vicinity.

Table 1:- Experimental sites.

N°	Region	Department	Locality
1.	Center	Haute Sanaga	Nanga Eboko
			Nkoteng
		Lékié	Batchenga
			Nyong et So'o
2.	South	Mvila	Ebolowa
		Dja et Lobo	Meyomessala
		3.	East
Kadey	Batouri		

In order to measure on the field, the relative amounts of sand, silt and clay in the soil, the jar sedimentation method was used. Once the percentages were calculated, the soil textural triangle was then used to determine the soil type. (Andrew, 2019).

Determination of limits of moisture content

For the program to define if the soil is workable or not, it has to determine if the moisture content on any specific day is lower or greater than a threshold (moisture content at wilting point and critical moisture content) that could impede on the usage of farm machinery and implement. It is for these reasons that the soil moisture levels that could be detrimental to the soil when using farm machinery was determine both at field and laboratory levels.

Lower threshold values

The moisture content of dry soil (wilting point) was assessed for the different soil types to identify and set the lower limit of the value of the moisture content that was detrimental to the use of farm machines in the program. Soil samples of about 2kg each were collected from the study sites at a depth of 0-15cm for the topsoil, using a spade and are then placed in bags and once in the lab, the soils were placed in trays for air drying at ambient conditions for 24 hours (Figure 2).



Figure 2:- Samples set for air drying.

This parameter was assessed using the core (volumetric cylinder) method. A core of volume 100cm^3 and height 4cm was inserted completely into the soil with the help of a hammer (Figure 3) and a core cover, to avoid destroying the borders of the core, to a depth between the first 0-15cm corresponding to the topsoil and the next 15-40 cm soil layer corresponding to the subsoil layer. A spade and a knife were used to remove the soil-filled core and its end was trimmed to suite the volume of the steal core. The samples after collection were placed and sealed in polythene-lined plastic pots of thickness $>50\mu$ and labeled.



Figure 3:- Core ring being hammered into the soil at 0-15cm and 15-40 cm depth.

Once at the laboratory, the soil samples were weighed using an electronic balance, to have an initial mass of the soil m_w . The soil samples were next oven dried for 24 hours at 105°C and allowed for an hour in a desiccator (Figure 4), for the samples to get cold after which the dried samples were weighed once more with an electronic balance m_d . the moisture content was assessed as:

$$\omega = \frac{m_w - m_d}{m_d} \times 100$$

Where:

m_w : Initial soil sample mass (g); m_d : Final dried soil sample mass (g); ω : Gravimetric soil moisture content (%).



Figure 4:- Adventurer pro electronic balance (A) and desiccator (B).

Upper threshold values

The soil compaction characteristics was done using a small proctor (Figure 5) in laboratory. The principle behind the test consists of humidifying the soil sample at different moisture content Q and to compact it in a normalize mould using a harmer of weight 1.016 kg to determine the maximum amount of soil water that could yield maximum compaction. For each compaction test corresponding to a given moisture content, the bulk density was determined and a curve was drowned to demonstrate the variation of soil moisture content and bulk density. The maximum point on the curve corresponds to the critical moisture content ω_{cr} and a detrimental bulk density γ_{dopt} on the X and Y-axis respectively. This was determined for the different soil types in the area of study.



Figure 5:- Small proctor hammer, mold and collar (from left to right).

200g of a sample was measured with the help of an electronic balance and a placed into a dish. Using a 50cm³ burette containing water, the 200g soil sample was humidified at the desired moisture content (Q) and with the help of a spatula, the soil is well mixed to homogenize the applied moisture.

The moistened or humidified sample was divided into 03 parts (layers), each weighing approximately 67g. The first sample was placed in the mold and with the help of harmer, 6 blows are given to the layer from a height of 0.25m after which the remaining layers were successively added and receiving the same energy.

The collar was removed and well-trimmed into the mould with the use of a knife after which the content of the mould was removed and placed into a 250 cm³ beaker. The beaker was weighed to obtain wet mass (m_w) and later on oven dried for 24h at 105°C. The sample was then weighed later to have dry mass (m_d) and the bulk density (γ_d) and moisture content (w_c) are calculated using (equation 2.4 and 2.5) the same procedure is then repeated for all the samples.

Determining humidifying levels

The air-dried samples were grinded in a mortar to break dry soil lumps and later on sieved with the use of a 2mm sieve in order to have a more homogenous samples in terms of size (Figure 6). 15g of the air-dried and sieved samples from each site was weighed using an electronic balance and are then oven dried at 105°C for 24h after which they were removed and placed in a desiccator for it to cold. The dried mass of the samples was measured on the balance and recorded (M_D). From which the residual moisture contents (w_r) for each sample are gotten using (equation 1) and the humidification levels (Q) were calculated for a chosen moisture content (ω_{ch}) with the help of (equation 2) taking into account the field capacity as a reference (Table 2).



Figure 6:- Grinding (A) and sieving (B) soil sample.

$$w_r = \frac{15 - M_D}{M_D} * 100 \tag{1}$$

$$Q = (\omega_{ch} - w_r) * 2 \tag{2}$$

Table 2:- Data collection table for various humidifying levels.

$\omega_{ch}(\%)$	15	17	19	21	23	25
$Q(\text{cm}^3)$						

Ambassa (1978)

Ngtract Model design

Agrometeorological data collected from meteorological stations were examined, and their applicability to agricultural production were discussed. The first step was to estimate the number of Field Workable Days (FWD). The model that was created was based on the budgeting of soil moisture and the establishment of tractability standards with regard to the critical moisture that led to unfavorable bulk density. Agrometeorological and other data were used to apply the model to the study areas. The model includes a soil moisture balance sub-model that uses soil moisture content in the top and subsoil layer as a criterion to determine daily soil tractability conditions. It was designed to predict the next day's rainfall, which will have an impact on the practical tractor work period.

A model's different parts need to have a solid theoretical foundation in order for them to be broadly applicable. In light of this, an effort was made to include the top theories and techniques described in the literature. As a result, it was crucial to put together a linkage between the model's various parts so that they could be used as subroutines and functions. As a result, when better theories and techniques are developed, various system components can be changed with ease.

Agro-meteorological and other variables

Agrometeorological and hydrological data that were collected daily overtime were necessary for determining workability of a day. Some data (rainfall, evapotranspiration) were obtained from SOSUCAM (Sugar production company), IRAD's (Agricultural Research Institute for Development) meteorological station, while others were derived from empirical formulas. The empirical formula developed by FAO (1991) was used to calculate runoff.

By observing the activities of the farm operators in the three regions that make up the Bimodal Humid Forest Agroecological Zone, actual observed field workable days were obtained. Days that could not be used for fieldwork

due to rain, excessive moisture, or insufficient moisture were noted. This data was to help test and validate the NGUTRACK model.

Soil water balance model

The NGUTRACT model was created with the idea that the following factors influence the amount of soil moisture that is readily available:

1. Water input: irrigation and precipitation.
2. Water output: drainage, evapotranspiration, and surface runoff make up.

The model uses International unites system (SI) only (mm).

According to the theory behind the water balance model, the moisture content on any given day is the difference between the soil's moisture content of the day before, plus any additions from irrigation or precipitation, and the losses from runoff, drainage, and evapotranspiration. This was calculated as in equation 3 (Ahaneku and Onwualu, 2007):

$$M_i = M_{i-1} + P_i + I_i - R_i - D_i - E_{tai} \quad (3)$$

Where,

M_i = Soil moisture content on day i , mm.

M_{i-1} = Soil moisture content on the previous day $i - 1$, mm.

P_i = Precipitation on day i , mm.

I_i = Irrigation on day i , mm.

R_i = Runoff on day i , mm.

D_i = Drainage on day i , mm.

E_{tai} = Evapotranspiration on day i , mm.

- Precipitation was obtained from meteorological station (SOSUCAM). It can also be input manually from farmers that collect daily rainfall data;
- Runoff= Runoff coefficient (K) x rainfall (when $P_i \geq 4\text{mm}$) (FAO, 1991);
 - o Runoff coefficient (Annex 4).
- $E_{tai} = E_{tp} \times K_c$ (Selirio and Brown, 1972).
 - o $E_{tp} = 0.7 \times E_{pan}$ (Doroombos and Pruitt, 1975),
 - o E_{pan} data (quantity of evaporation at a given location) were obtained from meteorological observations (SOSUCAM)
 - o But $E_{tai} = E_{tp}$ (if Crop coefficient $KC=0$)
- Irrigation = Daily water requirements = Evaporation x KC (WAAA, 2018)
 - o Can also be input manually (but $i=0$ for rainfed agriculture)
- Drainage = $FC / (2 \times \text{dry moisture content}) (R > 4\text{mm})$ (Agus, 2004)
- FC = Field Capacity (from field data).

Following the computation of soil moisture, a set of standards was used to determine whether the soil was suitable for field operations.

Field working day criteria and programming

Soil tractability refers to a farm's ability to allow a machine to operate and perform its function efficiently without damaging or being damaged by the soil. For agricultural tractor operations, the soil is workable if it has sufficient bearing strength to support the machine's weight, can develop adequate shear resistance to avoid slip and soil damage, and can produce good soil tilth without the formation of large clods. This soil behavior varies according to soil type and operation. It is also affected by the soil moisture level. Based on actual field observations of machinery operations, the soil is considered workable in this study if the moisture content is less than the critical moisture content, which varies depending on the soil type. Also, if the previous day was a workday and the precipitation today was less than 4mm, the soil is workable. According to the literature, light and intermediate rainfall events (i.e., 5-15 mm) increased water content in litter and soils at depths ranging from 0 to 80 cm. This information was used to determine which days were considered rainy. Also, if the moisture content of soil tilth is greater than the permanent wilting point, the day is not a work day.

The program used as input:

- Date of the day. This datum will permit the program to compute the moisture content of the previous day.

- Precipitation: the amount of rainfall permits to compute the amount moisture content generated for a specific day.
- Soil texture: every farm being soil specific, each farmer introduces the height of the three soil elements that characterizes a soil texture: clay, silt and sand and the program calculates the proportion of clay, silt and sand to defines the soil texture.
- Evapotranspiration: this datum will permit the program to determine the amount water leaving the soil through transpiration and evaporation.
- Type of crop: this information will permit the program to determine the crop coefficient to use in the algorithm.
- Region: this parameter will permit to have the site-specific climatic parameters;
- Irrigation: this information is used to assess the additional amount of water that can be added into the system for irrigated agriculture.
- Pan Evaporation: in addition to other variables, it is used to determine evapotranspiration

The program computes the moisture content and compares to the critical moisture content upper and lower limits and define days that are workable and days that are not.

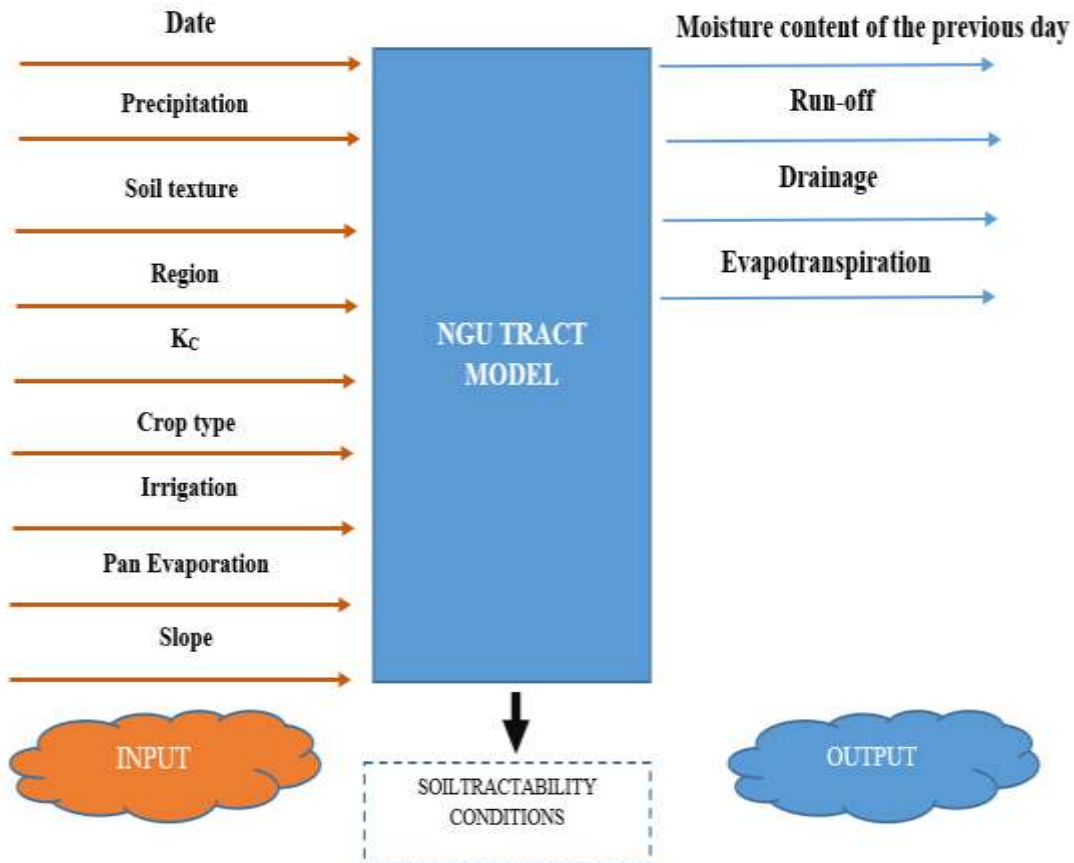


Figure 7:- Various input parameters for NGUTRACT model.

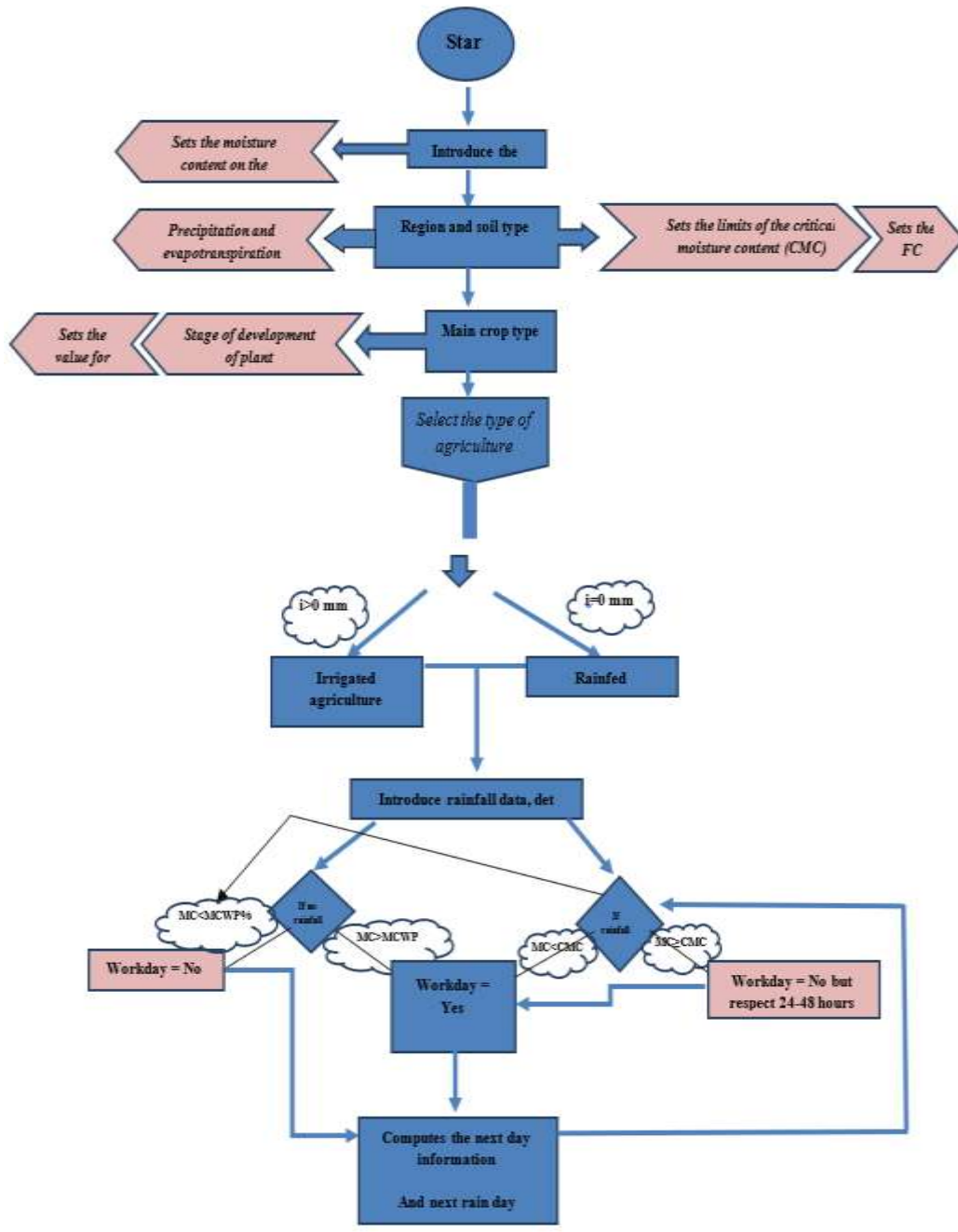


Figure 8:- Flow chart of NGUTRACT model.

Model verification and validation:

The model was validated after a correlation analysis was carried out between field data and modelled data. The average number of working days for was calculated using this model. The results were then compared to the actual number of working days for those months

Results And Discussion:-

Soil texture

Using the bottle sedimentation method, the soil components were able to sediment, with denser component (sand) being found at the bottom followed by the silt and clay component as predicted by Stokes law. However, it was

observed that the ferralsols in the study sites are predominantly composed of clay. Soils on the fields were red in color, hence confirming their ferrous nature. Four types of soil textural classes characterize the soils in the area of study as presented in the Table 3.

Table 3:- Soil texture of ferralsols in the Bimodal Humid Forest Agroecological Zone.

Sampled site	Soil particle composition			Soil texture	Location
	Clay (%)	Silt (%)	Sand (%)		
Nkoteng	32,3	19,4	48,4	Sandy clay loam	4°32'37.89''N / 12°01'12.95''E
Nanga Eboko	50,8	15,4	33,8	Clay	4°38'18.44''N / 12°22'47.90''E
Batchenga	40,3	22,6	37,1	Clay	4°17'24.96''N / 11°37'48.89''E
Mbalmayo	39.0	16.0	45.0	Sandy clay	3°32'26.69''N / 11°30'13.50''E
Ebolowa	41.7	28.4	29.9	Clay	2°56'54.58''N / 11°08'41.74''E
Meyomessala	49.5	19.1	31.4	Clay	3°06'23.75''N / 12°15'20.61''E
Ndokayo	35.7	34.8	29.5	Clay loam	5°30'02.78''N / 14°06'27.94''E
Batouri	39.1	28.2	32,7	Clay loam	4°26'13.66''N / 14°23'00.30''E

The majority of the soil sample exhibit a dominant clay nature (75%). The clay nature of these soils could equally be used to predict the extent to which farm machinery could compact the soil during, owing to the high moisture holding capacity of clay soils.

Moisture content at wilting point

The moisture content at wilting point was found to range between 10% to 15%. It was observed that soil texture with high proportion of clay were found to have higher value of water content as presented in table4.

Table 4:- Moisture content of dry soil.

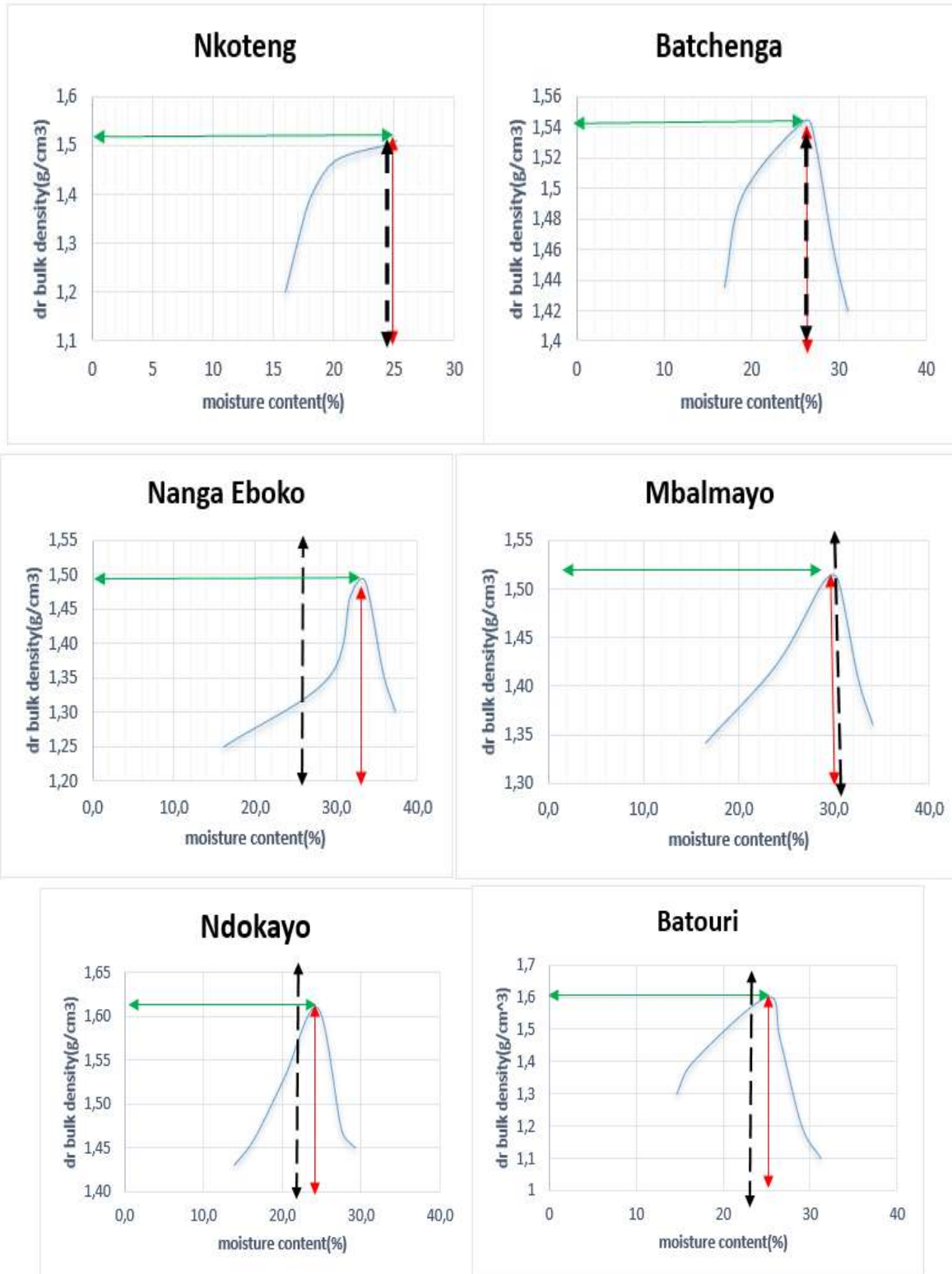
Soil texture	Mc dry soil (%)
Sandy Clay Loam	11
Clay	15
Sandy Clay	13
Clay Loam	10

These results are in correlation with the findings of Pragyana and Arulmozhiselvan (2019), NRCCA (2022), and according to these authors, the volumetric soil moisture content at the wilting point ranges from 5 to 10% for sandy soils, 8 to 15% in loam soils, and 15 to 20% in clay soils. Similar results were also reported by Amooh and Bonsu (2015) who stated that the clay texture had more moisture saturation than coarse textured soil (loamy sand and sand).

It was observed that the soil texture significantly influenced the soil water content. Among the various soil texture identified in the forest bimodal agroecological zone, fine clayey texture (clay, sandy clay) recorded high water retention at wilting point.

Assessing critical moisture values leading to detrimental bulk densities

Plotting the graph of the moisture content vs the dry bulk density of the soil samples permitted to determine the critical moisture content and bulk density as presented in the Figure 9.



←---→ = field capacity
 ↔ = optimum moisture content
 ↔ = critical bulk density
Figure 9:- Plots if critical bulk density and corresponding maximum moisture.

From the soil moisture and dry bulk density relationship, obtained for the study sites it was found out that; soils at Nkoteng are less sensible to compaction when compared to soils of other sites, following the various level of humidification applied. This could be as a result of the sand content, which is highest in Nkoteng (48.4%).

Saini *et al.* (1984), in their research term the moisture content susceptible to unfavorable soil compaction critical moisture content. In their study, these authors reported critical moisture contents range from 25.88 to 38.32% which is in line with the result of this study (24.5 to 33.50%).

The field capacity was assessed (24h-48h) after a rain to appreciate and compare with the maximum moisture content at critical bulk density (Table 5). From the exception of Mbalmayo and Nkoteng, all (75%) the other sites have their optimum bulk density at moisture content greater than field capacity. Thus, with regard to the results, it shows that in majority, carrying out mechanized activities at such moisture content will preserve the soil from damage. Gürsoy *et al.* (2021) found out that maximum soil compaction occurred when soil moisture which is at or near field capacity, however, the field capacity was found to constitute a period where farm activities might yield compaction not detrimental for plant growth

Table 5:- Values of maximum moisture content against field capacity.

N°	Study sites	Field capacity	Critical moisture content
i.	Nanga Eboko	28.09	33.50
ii.	Nkoteng	25.45	25.22
iii.	Batchenga	25.36	27.30
iv.	Mbalmayo	31.89	30.40
v.	Ebolowa	22.02	27.00
vi.	Meyomessala	27.07	30.00
vii.	Ndokayo	23.18	24.50
viii.	Batouri	23.44	25.10

Modeling

Available workable days for agricultural operations are influenced by both the soil's moisture content and its workability. The NGUTRACT model was used to define soil moisture requirements for assessing tractability conditions for soils in agroecological zones. Based on the upper limits (CMC) and lower limits (MCWP) of moisture content with relation to different soil types, this model allowed one to decide if a day was workable or not.



Figure 10:- A Day defined as workable or non-workable based on the limits of moisture content.

As a result, the model is very site-specific, and depending on the soil type and moisture content, a day may be workable for one farmer while being non-workable for another farmer in the same location who has a different soil type.

Running the model on historical meteorological data (rainfall and evapotranspiration) and comparing the findings to the observed workable days in the field permitted to appreciate the model. Figure 11 present the number of working days available per month generated by the NGUTRACT model for a clay soil type growing maize in a rainfed agriculture system in the Center Region

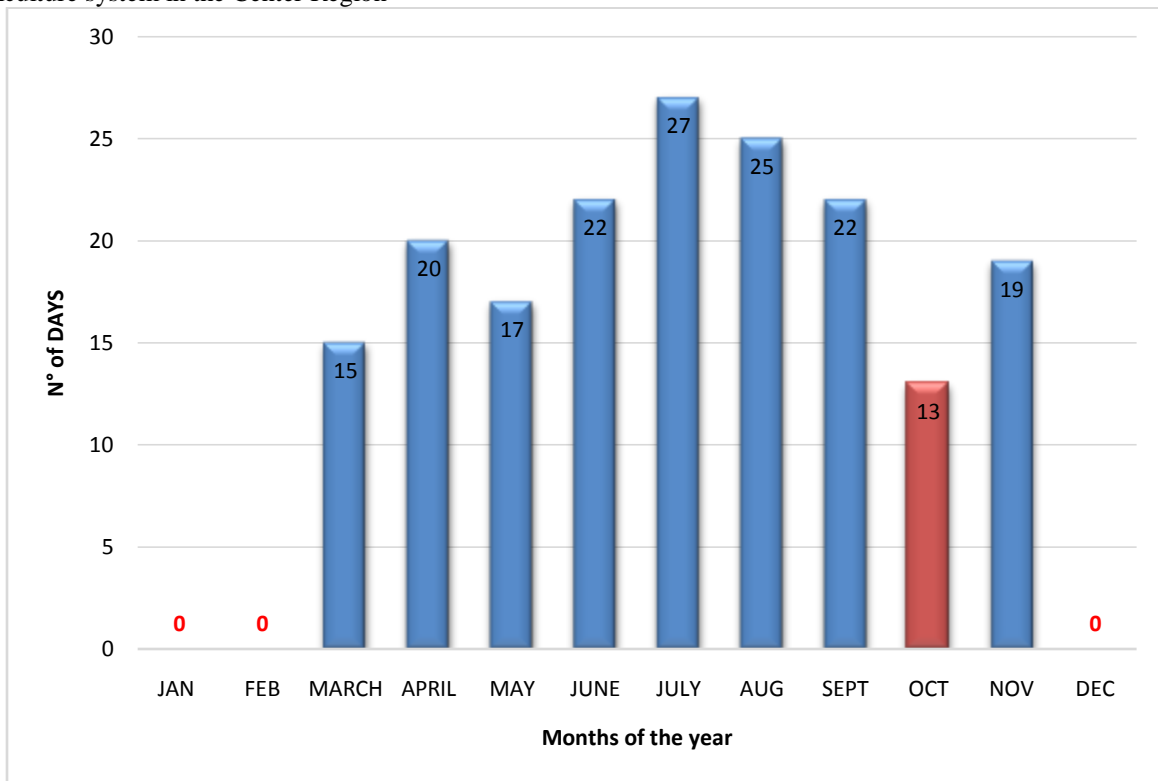


Figure 11:- Number of workable days generated by the NGUTRACT model for a farm.

The months of January, February, and December were observed to have the fewest number of workable days, which is understandable given that this is the dry season and the soil moisture content is too low to carry out any form of mechanization involving the movement of soil with an implement. However, value chains such as transportation and land clearing can be successfully implemented to some extent during this period. Because of the high moisture content, October was found to have the fewest number of workable days. This result is consistent with climatic patterns, as this month has the most rain days in the Center region. Rain falls for 23 days on average, according to climatic data.

The month of October corresponds to the period for maintenance, phyto treatment, and fertilization for the 30 days in that month, whereas effectively only 13 days are available for that operation.

The following example demonstrates the utility of Figure11. Assume a farmer wants to seed 50 hectares between March 1st and April 21st. Knowing that in the forest bimodal rainfall agroecological zone, he can plough 2 ha/day, harrow 4ha/day, and seed 4ha/day with a standard 75hp, it will take him 50 days to complete all of the activities. As a result, he has 50 workable days within that time frame. However, because of the weather, he will be unable to use tractors for more than 32 days, forcing him to consider alternative technologies that will allow him to work during the non-workable days, such as hand tool technology.

This type of data can assist a farm manager in making better machinery selection decisions and scheduling farm operations.

Testing and validation of the Model

It was critical that the NGUTRACT model's ability to anticipate system response be evaluated before it could be intended for any further professional or academic use. As a result, the model was tested using observed data on field

workdays for the Center Region for the year 2021 (with coordinates 4°17'24.96''N / 11°37'48.89''E) for a farm that cropped maize in a rainfed system. Table 6 presents the number of days observed as workable or not.

Table 6:- Observed field workable days in Center region in 2021.

Week	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct.	Nov.	Dec.	Day
W1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	1.
	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	2.
	D3	D3	D3	D3	D3	D3	D3	D3	D3	D3	D3	D3	3.
	D4	D4	D4	D4	D4	D4	D4	D4	D4	D4	D4	D4	4.
	D5	D5	D5	D5	D5	D5	D5	D5	D5	D5	D5	D5	5.
	D6	D6	D6	D6	D6	D6	D6	D6	D6	D6	D6	D6	6.
	D7	D7	D7	D7	D7	D7	D7	D7	D7	D7	D7	D7	7.
W2	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	8.
	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	9.
	D3	D3	D3	D3	D3	D3	D3	D3	D3	D3	D3	D3	10.
	D4	D4	D4	D4	D4	D4	D4	D4	D4	D4	D4	D4	11.
	D5	D5	D5	D5	D5	D5	D5	D5	D5	D5	D5	D5	12.
	D6	D6	D6	D6	D6	D6	D6	D6	D6	D6	D6	D6	13.
	D7	D7	D7	D7	D7	D7	D7	D7	D7	D7	D7	D7	14.
W3	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	15.
	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	16.
	D3	D3	D3	D3	D3	D3	D3	D3	D3	D3	D3	D3	17.
	D4	D4	D4	D4	D4	D4	D4	D4	D4	D4	D4	D4	18.
	D5	D5	D5	D5	D5	D5	D5	D5	D5	D5	D5	D5	19.
	D6	D6	D6	D6	D6	D6	D6	D6	D6	D6	D6	D6	20.
	D7	D7	D7	D7	D7	D7	D7	D7	D7	D7	D7	D7	21.
W4	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	22.
	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	23.
	D3	D3	D3	D3	D3	D3	D3	D3	D3	D3	D3	D3	24.
	D4	D4	D4	D4	D4	D4	D4	D4	D4	D4	D4	D4	25.
	D5	D5	D5	D5	D5	D5	D5	D5	D5	D5	D5	D5	26.
	D6	D6	D6	D6	D6	D6	D6	D6	D6	D6	D6	D6	27.
	D7	D7	D7	D7	D7	D7	D7	D7	D7	D7	D7	D7	28.
W5	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	29.
	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	30.
	D3	D3	D3	D3	D3	D3	D3	D3	D3	D3	D3	D3	31.
WD	00	00	10	27	21	20	21	28	28	19	27	00	
NW	D	31	28	21	03	10	10	03	02	12	03	31	

Yellow = workable day (WD)

Red = non workable day (NWD) because the moisture content is too low

Pink = non workable day (NWD) because the moisture content is too high

In order to appreciate the relation between the number of observed workable days (FWD) vs number of workable days generated by NGUTRACT model (MWD) a correlation analysis was carried out. Even though some discrepancies are observed in the monthly data between both variables on monthly bases, a significant positive correlation was observed. Figure 12 presents the number of workable days observed on the field and those generated by the model.

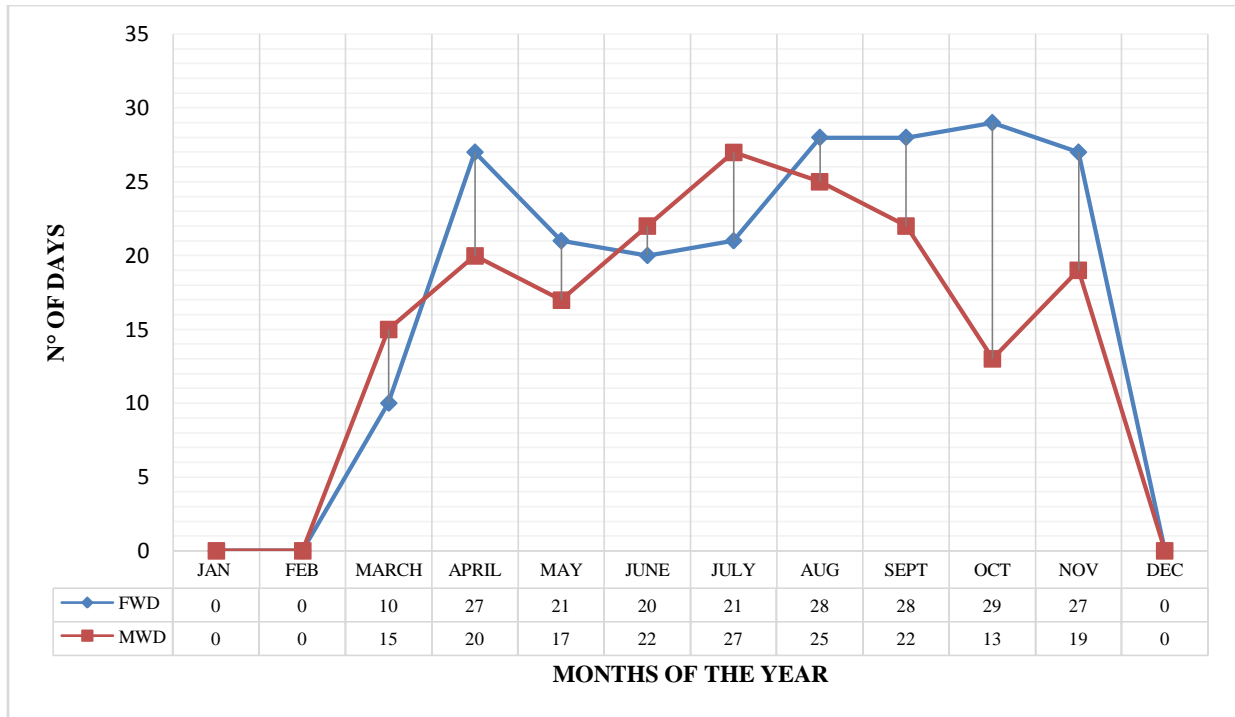


Figure 12:- Number of observed workable days (FWD) vs number of workable days generated by NGUTRACT model (MWD).

The correlation analysis for the twelve (12) months yielded the results as presented on table 7.

Table 7:- Correlation between field and observed data.

Correlations

[DataSet1]

Descriptive Statistics

	Mean	Std. Deviation	N
FWD	16,75	11,291	12
MWD	15,00	9,982	12

Correlations

		FWD	MWD
FWD	Pearson Correlation	1	,882**
	Sig. (2-tailed)		,000
	N	12	12
MWD	Pearson Correlation	,882**	1
	Sig. (2-tailed)	,000	
	N	12	12

** . Correlation is significant at the 0.01 level

According to correlation analysis, there was a highly significant correlation of coefficient between the predicted and actual workable days, (0.882). The two data have a strong, positive, and significant correlation. As a result, the tool is able to predict the workable days with adequate precision.

Conclusion:-

Based on soil water, precipitation, and some site-specific variables such as soil type, slope, crop type, irrigation, drainage, and so on, a predictive model was developed to forecast suitable field workdays for mechanized operations on Ferralsols in Cameroon's Bimodal Humid Forest Agroecological Zone.

The model was put to the test in order to determine the most productive days for farm activities in the Center Region. It was also validated by comparing its predictions to suitable field workdays data for the same region on Clay soils.

The comparisons between the observed and predicted available time for field work for various years shows that the model is reasonably accurate in predicting tractability conditions. Thus, the model can help a farm manager to make better machinery selection decisions and to better schedule farm operations. Time available for field work is affected by soil moisture criteria.

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