DEDICATION

This project work is dedicated to God Almighty, the Alpha and Omega. May His Name be praised.

EFFECT OF VEHICLE SPEEDS ON QUANTITY OF MATERIAL LOSS FROM UNPAVED ROAD SURFACE

(A CASE STUDY OF KAMPALA ROAD, BOSSO L.G.A, NIGER STATE.)

BY

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CERTIFICATION

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you are a man that wants men to rise after you. The Grace of God be sufficient for you.

To my friends and colleagues: Niyi, Bosun, Seye, Sadiq, Kizito, Dorcas, Samuel, Simeon, Kazeem, Amobi, Keneth to mention but few who are all Engineers and scientist in their respective fields. Thank you all.

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ABSTRACT

This project is a study of the effects of fugitives dust lost from unpaved road. The effects on people, animals and plants have been studied. To achieve these, five different vehicles that ply the road were individually made to run across the road section at varying speed limits.

Amount of dust particles ranging between 24.47g-214.2g after seven passes on an 100m unpaved Kampala road, Bosso LGA, Niger State. Results from suitable road and soil analysis showed that the particles collected ranged between 0.063mm – 6mm in size, plastics limit of 17.5%, liquid limit 45.2% and plastic index of 27.7%. The plasticity index of the dust particle is higher than the suitable range of 19 – 26%.

The results of the questionnaire administered to the villages revealed that vehicles do not ply the village constantly but on market days, the traffic density ranges from 20 – 60 vehicles per day. Due to the nature of the unpaved road, farmers are charged between ₦2400–₦2600 per full load of Pick- up Van to the nearest market (Beji), which is about 12Km away.

The significance of the loss materials in terms of increasing effects of dust emission as its causes health hazards like: running nose or catarrh, constant sneezing and some were reported to have been infected with whooping cough, Bronchitis and Bronchioxitasys majorly in the dry season.

constant sneezing and some were reported to have been infected with whooping cough, Bronchitis and Bronchioxitasys majorly in the dry season.

If the unpaved road is treated with chemicals like waste sulphur and local materials like water and palm oil, which are all dust palliative, the traffic accident will also be reduced. The unpaved road should be stabilized or paved in order to enhance comfort while driving on wheels.

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NOMENCLATURES

C_u Uniformity coefficient

C_c Coefficient of gradation or curvature

S_o Sorting coefficient

P.C.U Passenger Car Unit

A_p Area of paper

d_w Wet density

V (m/s) Ground velocity of the wind

g (m/s^2) Acceleration due to gravity

d (m) Soil particle diameter

a, β Are the empirically determined constants

α Albedo

CHAPTER ONE

INTRODUCTION

1.1 PREAMBLE/BACKGROUND

Soil is the upper layer of the earth crust in which plants grow. The forces created by the passage of powered machinery on the soil cause it to deform and rupture. In order to ascertain the quantity of materials lost from an unpaved road surface, some parameters, relating to the soil must be taken into consideration. These include soil structure, soil strength, soil density, soil moisture, soil hardness, soil texture and soil P^H.

Each of these has its relative properties in different types of soils. The loss materials from unpaved road given rise to dust emission and the amount of materials lost from the road depend on the nature and characteristics of both soil, vehicle and the environmental conditions. Specifically, the loss of materials from the unpaved road surfaces is mainly as a result of non – availability of selected and processed materials to bond the soil and other dust constituent on the road surface together, as well as the non – redistribution of the applied vehicle road.

1.2 STATEMENT OF PROBLEMS.

The basic interaction between the running gears i.e. the wheels and the road terrain gives rise to dust emission on unpaved roads. Unpaved roads are common across the local rural landscape i.e. in the rural communities'. The usual problem is major when the terrain is soft soils, muddy and some other problems are excessive wheel or track sinkage, excessive wheel or track slippage.

Unpaved roads are often narrow offers residents' connection with path and carriage roads. They are bounded by mature shade trees. During the dry seasons, these roads generates high amount of dust particle as a result of vehicle interaction on the unbound surfaces of the road or terrain. In addition to the traffic effect, dust is also generated by the Climatic influence of wind.

Analysis shows that unpaved road traffic produce about 35% of Atmospheric pollution Worldwide of this, 28% is from dust while 7% is from the exhaust gas respectively (WHO, 2000). Unpaved roads and road related projects could contribute to polluted run off or non point source pollution.

In addition, unpaved roads are easily eroded in the wet season, are very slippery and impose a greater danger to user and some cases dislink users leading to a greater level of economic imbalance, damage and spoilage

of agricultural and industrial raw materials and generally lead to abject poverty since about 75% of Nigeria's Total population is found in the Rural Areas (Aboaba, 1998).

As a result of dust emission, unpaved roads are quite risky to travel on because the dust emitted on these road surfaces reduce visibility and vehicle efficiency along side increasing environmental and health problems.

1.3 AIMS AND OBJECTIVES

The aims of this research work were:

-To quantify the amount of dust particles generated on the road due to vehicles of different characteristics.

-To investigate the effects of problems associated with quantity of materials loss from unpaved road surfaces on the nearby inhabitant, plants, environment and the economic growth of the area.

1.4 SCOPE OF WORK

-Collection and analysis of site soil

-Runs of 5 different types of vehicles on a 100m section of the road at varying speeds.

-Collection of dust generated at every per vehicle

-Administration of questionnaires to ascertain the effects of dust on the villagers living around the road and using the road, plants and environmental population.

-Evaluation of the effects of the road on the economic growth of the villagers.

-Analysis of results.

-Conclusion and Recommendation.

CHAPTER TWO

2.1. LITERATURE REVIEW

In other to assess the dust retaining characteristics of the gravel wearing courses, it was necessary to quantify the amount of fine airborne materials dislodged from the road relative to vehicle speeds and types. Subsequently some pilot studies were devised and implemented in following way section of unpaved road were chosen from the secondary network located north east of mount Kenya, these were subjected to passes of a standard vehicle traveling at a constant speed. The standard vehicles were a ford cortina estate car, hand rover LWB station wagon, and Bedford J4 lorry (TRRL, ,1984).

The speeds of the vehicles covered a range of 50 – 100 Km/hr in the case of the car and the land rover, and the speed of 50 and 65Km/hr with the lorry. The speeds adopted for the lorry were a function of the capability of the vehicle and not an experimental limit. Sample of the airborne fine materials dislodged from the road during experiments were collected in metal trays placed adjacent to the running surface on the side of the road. These trays measured 1.220mm x 1220mm (4' x 4') and were arranged in a square grid covering an area 12,200mm x 12,200mm 40' x 40'(Jacobs and Sayer, 1972).

All the materials collected on each tray were weighed and subsequently measurements of particle size distribution, moisture content and plasticity were determined. The wind speed and direction at the experimental site was measured by an anemometer adjacent to the collecting trays.

The results of the study shows the rate of airborne materials removed from the road for a specific number of traffics passes for vehicles traveling at different speeds. In the Cortina car it was found possible to carryout additional test at intermediate levels of speed. It was not possible to obtain a complete service of test with the Bedford lorry due to mechanical failure of the vehicle on the day of the tests; the roads were closed to all traffic other than the experimental vehicles for period 8.00 am – 4.00 pm. The effect of wind erosion must have been a contributory factor as well the linear speed which would suggest that dust is created in the speed range 0 – 70Km/hr. Although the losses in those cases were primarily due to exposed roads particularly with surface distributed by traffic or rainfall, the effects of wind erosion over a period of time may be significant. All the dust tails discussed in this section were carried out on dry day with wind speeds of less than 5Km/hr and usually in the 1 – 3 Km/hr (Jones, 1984). As the tests were over

a relatively short period of time the effect of wind erosion were assumed to be negligible.

According to the recent research findings and survey data in Nigeria, out the 194,000 road network nationwide 16% of the roads are Federal roads, 17% of the roads are State owned roads and 67% of the roads are rural roads or less developed which are probably maintain by the Local Authorities in charge (FOS and FMWH, 2000).

Although some urban areas which have unpaved roads, are not major roads but otherwise they are road link to other major roads.

Recent research by(FEPA,2002)Nigeria revealed that emission of particles is independent of how much silt a road surface is contained. Based on all these research and findings, similar solutions are suggested and requited to reduce and check particle emission especially on unpaved roads. The recommended solutions for the remedial treatment used for dealing with dust problem on unpaved roads are as follows:-

a. Application of bituminous seal.
b. Coating with deliquescence salts.
c. Application of water sulphur liquor.
d. Application of gravel.

e. Admixture of various local materials such as molasses bamboo palm oil, vegetable oil, animal fats, lime charcoal and many others.

f. Addition of water.

All these treatments, with the exception of the bituminous seal, are temporary solution. Frequently they need to be applied several times a year. Apart from the use of local materials, they are also expensive.

Generally, dust particle emission on unpaved roads had been analyzed from different perspective and with different background of understanding. This research and the report concentrate and relate the emission with the effects of soil type, vehicle characteristics and vegetation along interaction on the unpaved road surface.

Also the research also takes into cognizance at the sometimes effects of climatic, environmental and vehicle characterizes leading to emission of fine particle on any given unpaved road section.

To achieve the stated and implied objectives and aims research was made across different field of studies such as; the Road Transport Corporation, the Environmental Protection Agency, road and the Construction Companies, the chemistry of environment, the soil science and soil mechanics, the health and medical studies etc.

Effort in this dimension were used to facilitate the studying and finding specific effects and problems associated with dust from unpaved road surface due to vehicle and environmental effect leading to emission of these dust particles, cost incurred from dust effects in Agricultural product, Health, traffic and finally possible solutions were also suggested to reduce and in essence check dust and enhance dust free society (Bevan, 1974).

2.2 SOIL PARAMETERS

Some of the soil parameters that are found to be responsible for materials loss on unpaved roads as earlier mentioned are:-

SOIL STRUCTURE: This is mechanical property of a soil, which shows the workability of that soil. It's the mutual arrangement orientation and organization of the particles of the soil in layers. The term is also used sometimes with references to the geometry of the spaces and parents particles of different sizes. Formation of particles with sizes 0.25mm are referred to as micro – aggregate soil fraction (sizes) should not be less than 0.25mm during tillage, as thus can destroy the structure of soil aggregates (ASTM,1974).

SOIL TEXTURE: It is the most permanent physical property of a soil, the soil particle are designated by textural group as gravel, sand, silt and clay. The coerciveness the fineness of the soil gives its textural class.

SOIL HARDNESS: The ability of soil to resist pressure by a body inform of cones, cylinder or spherical objects. Soil hardness is a compactive index of mechanical properties of soil.

SOIL MOISTURE: This is the volume of soil that is occupied by solid particles only but filled with water and air. The soil moisture is considered maximum or saturated if water occupied ¾ of capillary spaces (Sultan, 1976).

Soil density: This is the weight per unit volume of soil wet density refer to soil weight + water, dry density (d_w) refers only to the soil high density indicates high bearing and shearing strength and low permeability.

MOISTURE CONTENT: Moisture of a soil is a percentage, comparing the weight of water to the weight of dry soil. It is determined by the following procedures: weight of soil sample – dry sample of spoil in the oven.

Reweigh the sample to determine the loss of moisture the weight of water lost, compared to the weight of dry soil is called the moisture content. It is usually expressed as percentage % mc = (weight of water / weight of dry soil) x 100/ 1(Warne,1957).

The moisture content is 32.0%

However, the vehicle characteristics intractability on the road surface that affects loss of materials depends on the nature of the soil materials on a given road and these include;

a. Soils being heterogeneous, that is their materials or engineering properties vary widely from point to point with a soil mass.
b. Soils being in entropy that is their engineering properties are not the same inn all direction.
c. Soils being non – linear, that is their stress – strain curves or not straight lines.
d. Soils being not conservative, that is they respond to almost everything that happens to them.
e. Soils in situ in the field are characteristics by joints, fractures weak layers and other defects in the materials.

As highlighted above, the grain size of the soil is important in identification. Therefore soil sample and dust particle are passed through sieves of various sizes to calculate the percentage of sample, which is gravel, sand, silt, and clay. Some other literature on soil mechanics would be discussed and helpful for accurate analysis of the soil test this includes:

- Determination for fine – grained soils.
- Determination of the particle sizes distribution.

- Determination of the liquid limit.
- Determination of the plastics limit.
- Determination of the plastics index.

2.3 MATERIAL LOST

Movement of agricultural machines, vehicles and equipment on an unpaved road causes a gradual compaction of the soil, not only on ploughed surface. The loss of materials from the unpaved road surface is mainly as a result of non – availability of selected and processed materials to bind the soil and other dust constituent on the road surface together, as well as the non – redistribution of the applied vehicle load. Then makes the road materials structure loose and less cohesive. It has several effects on the soil condition for cultivation, under this condition; it becomes increasingly difficult for water to permeate below the layer thereby causing soil erosion or water logging during wet seasons or causing the area to dry fast thereby facilitating wind erosion (dust emission).

The emission of the fine particle from the road surfaces arises from the loosening of the soil structure and a reduction in the cohesion of the gravel wearing caused by the action of traffic and climate.

The lost materials increase the permeability of the surface layer and result in the early development of early development of the pot – holes all of which

cost, dust emission, traffic accident, environmental and related hazardous effects.

2.4 DUST PROBLEM

Dust as been known in the research to be mainly a general traffic and safety problem. Environmental and health menace. Agriculture and industrial production set back all of which lead to low standard of national economy. Dust obscure visibility leading to many traffic accidents.

In Agriculture, dust particles settles or crops thereby adding to the processing stages, costs and its makes crops unattractive and reduce their economic and market values and a danger as food source. Also dust affects the stomata opening on the leafs of the plant thereby reducing the rate of transpiration in the plant (will be further discussed).

Domestically, dust in living homes causes chest pains, cough, eye and nasal irritation and excess death of 4000 persons usually worldwide. It also increases cost of maintenance and operation of vehicles farms equipment machines and buildings.

Hence, the adverse effect of dust to humanity and Agriculture purpose must be put to a stop.(US Environmental Protection Agency Region 2001.)

The project work on unpaved road is about the quantifying of road dust relative to vehicle speeds. Presently, Colorado State University in America has developed Dustometer, a dust measuring device, developed and used in this comparative study is a portable, quantitative and precise research tool which can be used in future dust studies (Colorado, 1998).

2.5 ROAD SAFETY

Unpaved road are generally very unsafe, they are prone to traffic accidents. Over the years they have recorded a higher accidents rate per kilometer than paved roads.

Research results revels in the USA that unpaved road claim about 230% people (lives) per vehicle kilometer as compared to paved roads and this is due to visibility and skidding off the road.

In Nigeria with reference to Niger state, as a result of reduction in visibility in the dry season, slipperiness of unpaved roads in the wet season and the poor geometric standard of the unpaved roads, the traffic accidents has risen and about 186 person die annually and about 319 are injured from the roads. This however could be under estimated since not all traffic accident on these roads are reported and recorded (Federal Road Safety Research 2002).

CHAPTER THREE

3.0 MATERIALS AND METHODS.

3.1. MATERIALS

Materials that were used in this experiment are:

ANEMOMETER: It is used to measure by displaying the wind speed of the experimental site. We have the manual and the Automatic type. The higher the wind speed, the higher the digital display moves fast. While the automatic types are usually stationary at fixed point which can record the wind speed of a particular Area to certain range of distance. The manual type is moveable to the site.

Name of Manufacturer: Vector Instrument, North Wales England

Type: A100R

Serial No: 4895 (year of model 1984)

WIND-VANE: This is an instrument used to determine the direction of the wind on the experimental site with the help of an indicator or a pointer arrow, which faces the source of the wind.

Name of Manufacturer: Vector instrument, North Wales England.

Type: W200P

Serial No: 5878

Potentiometer wind vane (AY77)

HYGROMETER: It was used to measure the relative humidity of the experimental site. The digital type was used.

Name of Manufacturer: Alder, England, UK.

Serial No: 00507

THERMOMETER: It was used to measure the temperature of the Experimental site before the vechile run and after the vechile runs. The digital was used.

Name of Manufacturer: Alder England, UK.

Serial No:00507

STANDARD SIEVES (BS SIEVES): They are used in the soil analysis test details in laboratory.

SUN RADIATION: This measures the intensity of the sun at the experimental site. The instrument used in recording the sun radiation is called GUN BLANNER or SUNSHINE RECORDER. It can measure intensity of sunshine to certain range of distance Area.

Name of Manufacturer: H.H.P.T (Ltd), London, England.

Serial No: RHAL:037

MEASURING TAPE: It is a calibrated rope or tape used in taking dimension majorly on linear distances on the experimental site(unpaved road).

THICK A1 SIZE PAPER: This is a white thick paper of specific dimension used to collect dust material through the covered length of 100m of unpaved road.

PINS/SHOE NAILS: It is the attachment material of the A1 size paper to the terrain or the road surface.

3.2. METHODS

An unpaved road section of length 100m was chosen for this experiment. On the Kampala road five different vehicles ran one after the other at seven different speeds of constant time interval. Mark the road section was marked red and white tape for caution for other roads users and to have a road diversion. On this marked road section, thermometer, hygrometer and anemometer were fixed adjacent position to the road and they should be fixed 3m away from the road edge.

The A_1 size paper was placed and pinned 2m away from the road edge which are joined together to cover the 100m length of the selected path of unpaved road. The papers are placed both on the right and left sides of the road where the vehicles are made to passed. The papers were to aid in collecting the generated dust particles while the instruments above determined the atmospheric condition at the experimental site.

Five standard vehicles were allowed to run across this road section at seven different times and at varying and also the design speed on the road. Only the tractor was subjected to three different times of passes due to the tonnage and weight of it.

The tonnage or the traffic density was between 16 – 20 per day, atimes its extends to 40 – 60 per day on market days and design speed is taken into consideration.

Other key equipments and instrument used to aid successful experimentation include:- Thick paper of A_1 size, measuring tape, pins, anemometer, wind vane, hygrometer and thermometer. On the other and the standard vehicle that were subjected to pass on this road section include: Tractor fiat 666 model, Nissan blue bird wagon SLX model, Toyota Dyna truck, Toyota liteace bus and Peugeot 504 car.

Samples of fine particles collected at each run of the different vehicles are given in table II of the result. The fine particles were collected on the thick paper and the fine particles collected were weighed in the laboratory using the ELECTROWEIGNING MACHINE (which is digital displayed).

Size distribution determines, moisture content and the plasticity index were also determined as shown on the result.

The wind vane and the anemometer and all other necessary equipment to determine the environmental factor were fixed at adjacent positions to the papers for collecting fine particle. Other needed parameters were obtained from the standard reference point.(MINNA AIPORT, METROLGICAL DEPT.) All value measured are shown on the result section.

3.3 TRAFFIC ANALYSIS.

This is concerned with the estimation of the number of trips into and out of various Traffic zones. It assumed that land use generates trips.

THE TRAFFIC FLOW ON UNPAVED ROAD LEADING TO KAMPALA AND ITS ENVIRONS

The traffic density / flow on Kampala road is the number of vehicle using the road per hour or day.

Generally the traffic flow is based on daily basis, but considering the hours of study of flow as 8:00am – 4:00pm (8hrs) for the study.

The passenger car unit (PCU) can be calculated. Note that PCU factors for vehicles are as follows:

Weighed value for Truck = 2

Weighed value for Bus = 3

Weighed value for Motorcycle = 0.75

Weighed value for Car = 1

Weighed value for Tractor = 2

PCU has no unit.

The PCU for ordinary days and market days was carried out for a week and thus, the average summary is as follows;

FOR ORDINARY DAYS

No of Cars that passed = 5

PCU = No of Cars x weigh factor = 5 x 1 = 5.

No of Pickups that passed = 4

PCU = 4 x 1 = 4

No of Bus that passed = 1

PCU = 1 x 3 = 3

No of Truck that passed = 1

PCU = 1 x 2 = 2

No of Motorcycle = 7

PCU = 7 x 0.75 = 5.25

Total passenger Car unit = 5.25 + 2 + 3 + 5 + 4 = 19.55 ~ 20

FOR MARKET DAYS

No of Car = 23

= 23 x 1 = 23

No of Truck = Nil

No of Cycle = 22

PCU = 22 x 0.75 = 16.5 ~ 17.

No of Pickups = 10 x 1 = 10.

Total PCU = 10 + 17.0 + 23

PCU = 40.

CHAPTER FOUR

4.0. RESULTS AND DISCUSSION

4.1. RESULTS

The variable speeds limits for each vehicle at each run are:-

VARYING SPEED (KM/HR)

VEHICLES	1st speed	2nd speed	3rd speed	4th speed	5th speed	6th speed	7th speed	8th speed	9th speed	10th speed
Tractor fiat 666 model	10	15	20	25	30					
Nissan Blue Bird Wagon SLX model	10	15	20	30	40	50	60	70		
Toyota Dyna Truck	10	15	20	30	40	50	60	70		
Toyota Liteace Bus	10	15	20	25	30	40	50	60	70	
Peugeot 504 Car	10	15	20	25	30	40	50	60	70	

The vehicles were made to run across the road section and finally at 70Km/hr. the dust generated at each speed is to be collected and recorded in accordance with the speed generating it. The tractor is made to run across the road section at 10Km/hr, 15km/hr, 20Km/hr, and finally at 30Km/hr. also, the tape to measure the clearance, tyre contact, area of vehicle. Again note the tyre pressure and treading as well as the exhaust pipe position of each vehicle.

Other vehicles were subjected to higher speed up to 70Km/hr respectively and the dust generated should be recorded alongside the vehicle speed producing it.

At the end of the experiment, all materials equipment and vehicles are to be removed from the road and the road is to be opened for all users.

The dust particles collected were analyzed by suitable soil / road materials test in order to determine size distribution, plastic limit, liquid limit and plastic index of the dust particle collected.

VEHICLE TYPE	TYRE CONTACT AREA (M^2)	TYRE TREADING	TYRE PRESSURE (KG/CM^2)	CLEARANCE (M)	VEHICLE DISTANCE FROM DUST COLLECTION POINT (M)	WEIGHT (KG)	EXHAUST PIPE POSITION
TRACTOR Fiat 666 model	Front: 0.018 Rear: 0.04	Zig-Zag	Front: 40 Rear: 15	0.52	2	4200	Vertically upward on left side
NISSAN Blue Bird Wagon SLX model	Front: 0.019 Rear: 0.018	Zig-Zag	Front: 40 Rear: 37	0.23	2	969	Horizontally backward on right side
TOYOTA Dyna Truck	Front: 0.022 Rear: 0.017	Zig-Zag	Front: 50 Rear: 46	0.40	2	1778	Horizontally backward on left side
TOYOTA Liteace Bus	Front: 0.019 Rear: 0.015	Zig-Zag	Front: 44 Rear: 42	0.34	2	1600	Horizontally backward on right side
PEUGEOT 504 Car	Front: 0.019 Rear: 0.018	Zig-Zag	Front: 40 Rear: 36	0.25	2	1350	Horizontally backward on right side

Table II. Records of vehicle speeds, amount of dust particles collected at 7 different run or pass at constant vehicle weight.

TRACTOR

Speed (km/Hr)	Dust collection on Left side of road (g)	Dust collection on Right side of road (g)	Total weight of dust collected (g)
10	15.30	9.27	24.47
15	21.70	19.20	40.90
20	36.20	29.50	65.70
25	36.80	31.10	67.90
30	38.50	35.70	74.20

Direction of wind: **Right to Left**

TOYOTA DYNA TRUCK

Speed (km/Hr)	Dust collection on Left side of road (g)	Dust collection on Right side of road (g)	Total weight of dust collected (g)
10	11.40	18.70	30.10
15	26.90	29.30	56.20
20	33.70	41.60	75.30
30	34.60	42.80	77.40
40	36.30	44.10	80.40
50	57.90	61.70	119.60
60	79.20	83.30	162.5
70	95.20	98.50	193.70

Direction of wind: **Left to Right**

NISSAN BLUE BIRD WAGON

Speed (km/Hr)	Dust collection on Left side of road (g)	Dust collection on Right side of road (g)	Total weight of dust collected (g)
10	11.97	19.35	31.27
15	28.20	31.70	59.90
20	35.00	43.60	78.60
30	36.20	44.50	80.70
40	38.30	47.10	85.40
50	61.26	65.40	126.60
60	88.30	87.35	175.65
70	101.60	106.12	207.72

Direction of wind: **Left to Right**

TOYOTA LITEACE BUS

Speed (km/Hr)	Dust collection on Left side of road (g)	Dust collection on Right side of road (g)	Total weight of dust collected (g)
10	19.20	11.80	31.00
15	31.00	27.80	58.80
20	43.00	34.50	77.50
25	43.30	34.80	78.10
30	43.90	35.80	79.70
40	46.00	37.60	83.60
50	64.20	59.50	123.70
60	85.50	82.80	168.30
70	102.00	97.00	199.00

Direction of wind: **Right to left**

PEUGEOT 504

Speed (km/Hr)	Dust collection on Left side of road (g)	Dust collection on Right side of road (g)	Total weight of dust collected (g)
10	19.80	12.30	32.10
15	32.10	28.90	61.00
20	44.10	36.00	80.10
25	44.90	36.50	81.40
30	45.60	37.10	82.70
40	47.90	39.00	86.90
50	66.90	63.00	129.90
60	89.40	87.30	176.70
70	110.50	103.70	214.20

Direction of wind: **Right to left**

Table III. Records of atmospheric and environmental condition at the field of experiment (site)

S / No	Atmospheric / Environmental condition	Mean measurement / standard value
1	Temperature	35.75°C
2	Sun radiation	15.0
3	Moisture / Humidity	24.5%
4	Wind speed	7.3Km/hr
5	Wind direction	North east (NE)
6	Latitude / location	10°N

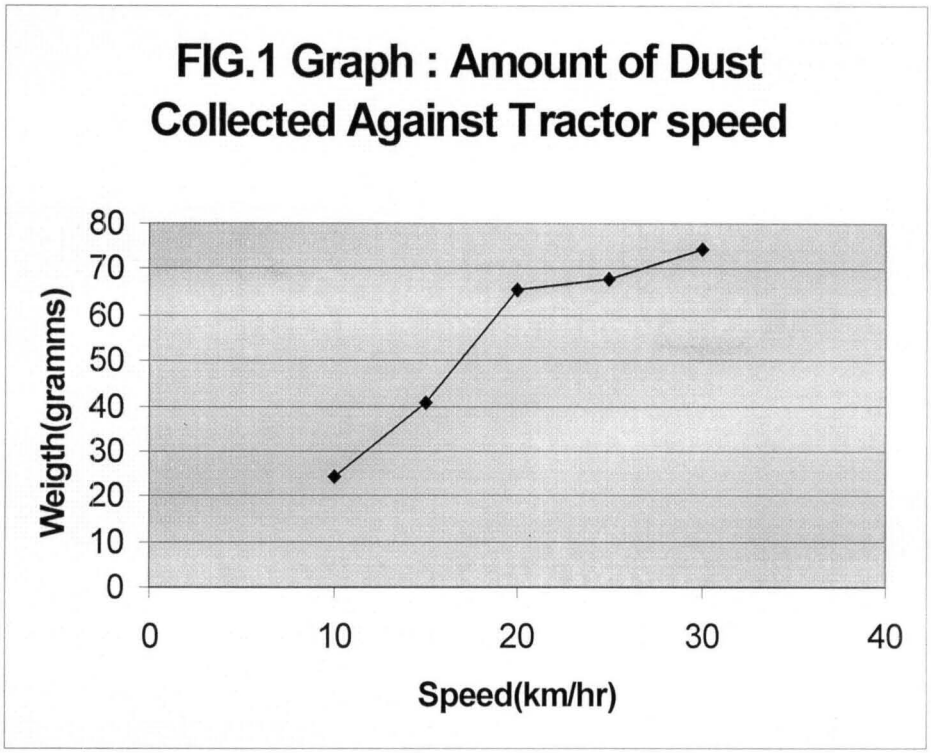


FIG.1 Graph : Amount of Dust Collected Against Tractor speed
Weigth(gramms)
80
70
60
50
40
30
20
10
0
0
10
20
30
40
Speed(km/hr)

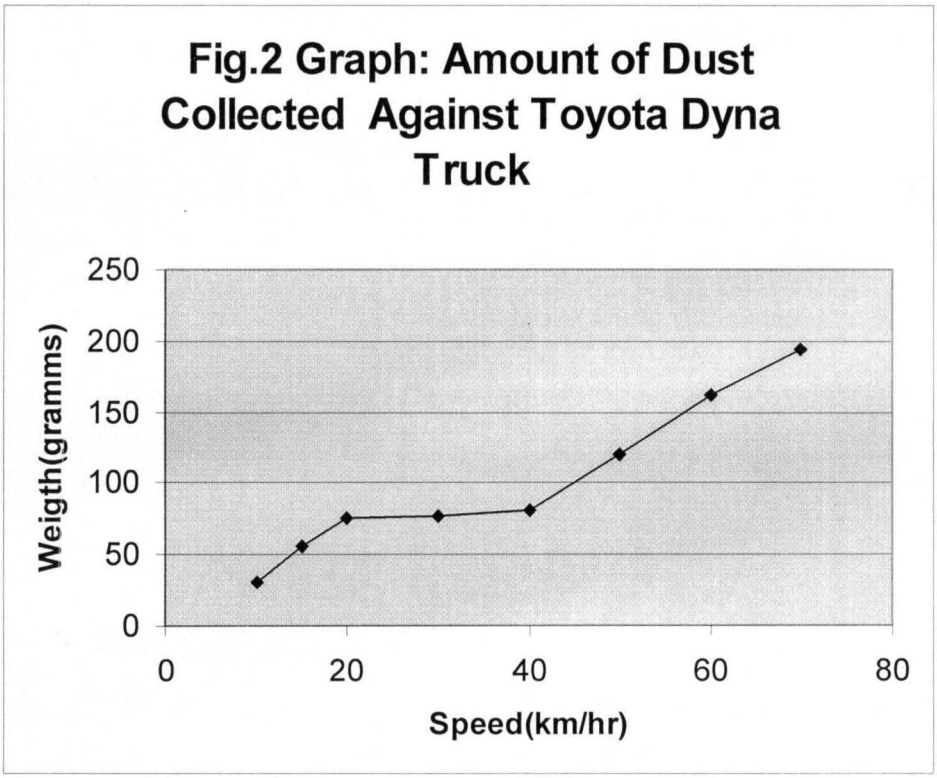


Fig.2 Graph: Amount of Dust Collected Against Toyota Dyna Truck
Weigth(gramms)
250
200
150
100
50
0
0
20
40
60
80
Speed(km/hr)

Fig.3 Graph: AMOUNT OF DUST collected Against Nissan Blue Bird Wagon

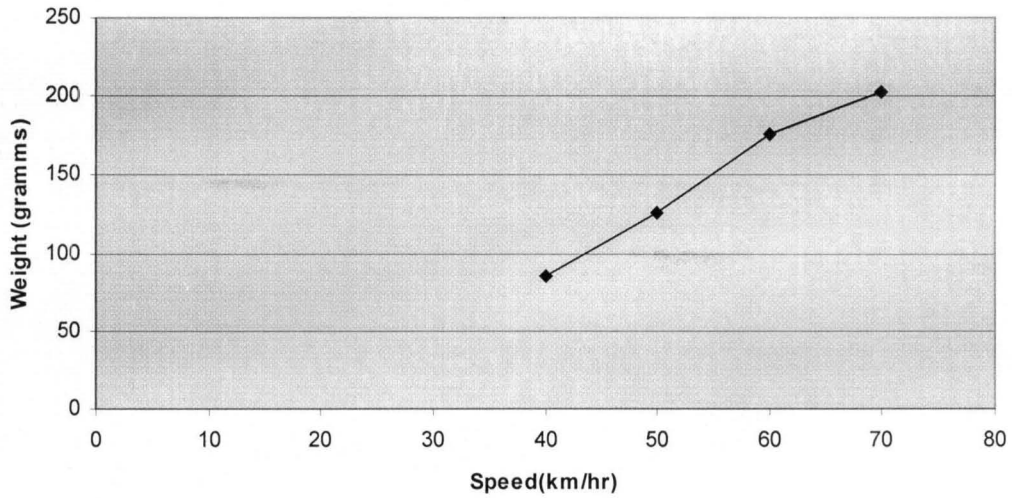


Fig.4 Graph: Amount of dust Collected Against Toyota Liteace

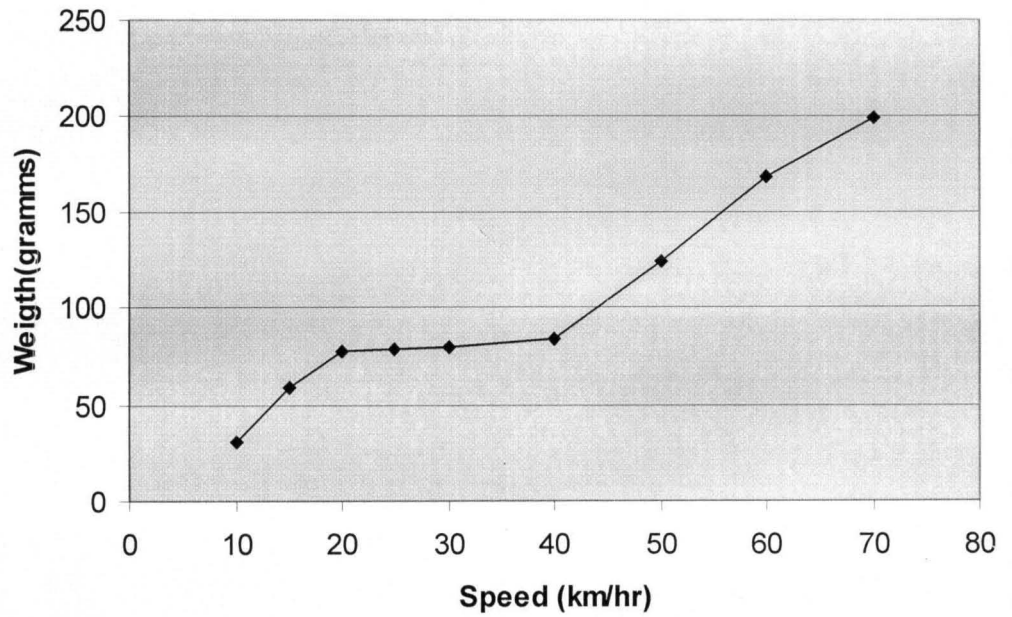


Fig.5 Graph : Amount of Dust Collected Against Peugeot 504 car

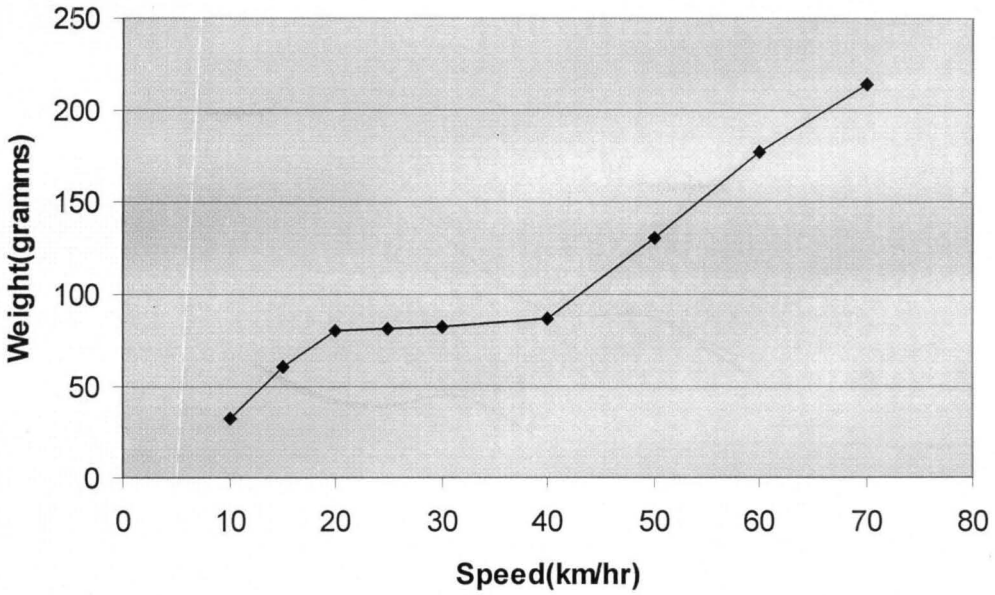


TABLE IV: sieve analysis for dust particles

S /No	BS 410 (μm)	Mass of empty sieve (g)	Mass of sieve + retained dust particles (g)	Mass of retained dust particles (g)	% retained on sieve	Cumulative of % retained on sieve	% finer (100 – C) passing.
1	63	338.71	347.37	8.66	28.77	28.77	71.28
2	75	330.10	332.88	2.78	9.23	38.00	62.00
3	150	317.15	319.23	2.08	6.91	44.90	55.09
4	212	304.74	308.00	3.26	10.83	55.74	44.26
5	300	296.58	298.80	2.22	7.37	63.11	36.81
6	425	306.25	313.25	7.00	23.25	86.36	13.64
7	600	284.19	286.29	2.10	6.97	93.33	6.67
8	Bottom pan	300.68	302.68	2.00	6.64	99.97	0.03

$\sum = 30.1$

From the Graph,

$Cu = D_{60\,2} / D_{10\,2} = 140 / 495 = 0.28.$

$Cu = 0.28.$

$Cc = D_{30}{}^{2}{}_{2} / (D_{60} \times D_{10}) = 340^2 / (140 \times 495) = 115600 / 69300$

Cc = 1.66.

So = $\{D_{15} / D_{25}\}^{½} = \{415 / 370\}^{½}$

So = 1.05

Table V: Sieve analysis of soil sample

S /No	BS 410 (μm)	Mass of empty sieve (g)	Mass of sieve + retained dust particles (g)	Mass of retained dust particles (g)	% retained on sieve	Cumulative of % retained on sieve	% finer (100 – C) passing.
1	63	358.62	525.81	167.19	23.33	23.33	76.67
2	75	335.84	370.81	34.97	4.88	28.21	71.79
3	150	332.03	379.16	47.13	6.57	34.78	65.22
4	212	316.32	374.38	58.06	8.10	42.88	57.12
5	300	304.29	372.89	68.6	9.57	52.45	47.55
6	425	295.93	371.82	75.89	10.59	63.04	36.96
7	600	308.36	456.06	147.70	20.61	83.65	16.35
8	800	287.80	343.64	55.84.	7.79	91.44	8.56
9	Bottom pan	300.64	361.69	61.05	8.25	99.35	0.65

$\sum = 716.43$

% Retained on sieve = (weight of soil retained / total weight of soil) x 100

Effective size: this is the diameter of the particle size distribution are corresponding to 10% finer passing.

A soil sample is well graded if the soil particle are equal, thus it is said to be of laterite formation with traces of clay and sand materials

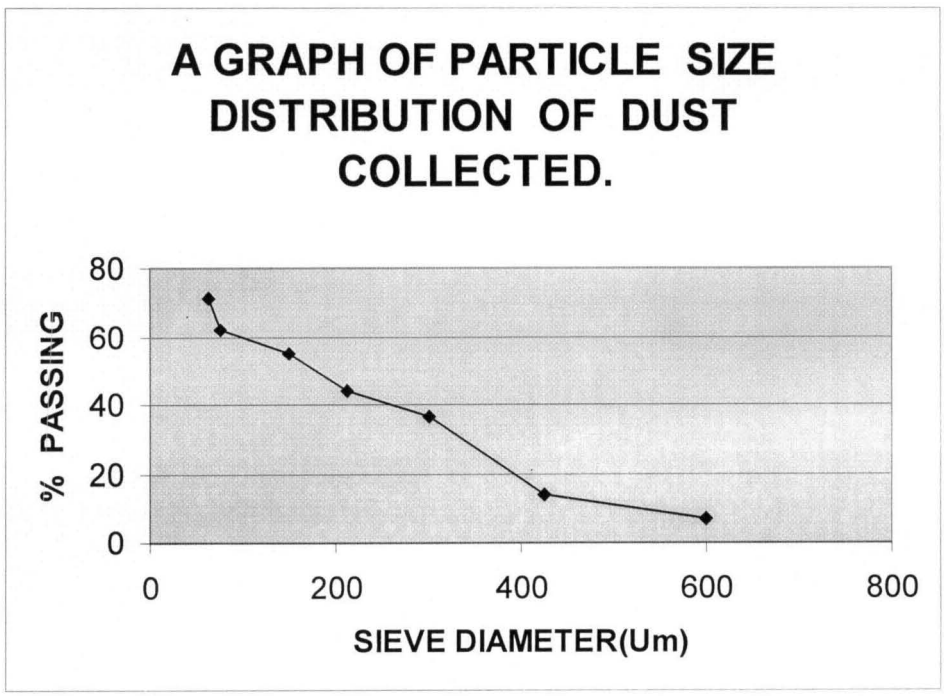
From the graph,

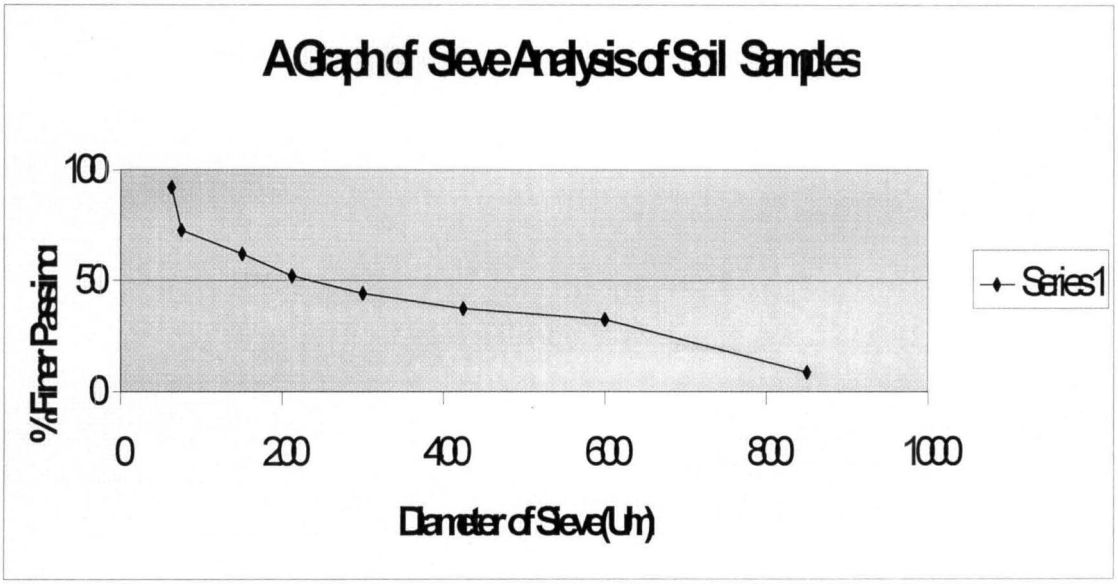
For Cu = D_{60} / D_{10} = 160 / 840 = 0.1904.

Cc = $D_{30}{}^{2}$/ (D_{60} x D_{10}) = $(630)^2$ / (160 x 840) = 396900 / 134,400

Cc = 2.95

So = $\{D_{15} / D_{25}\}^{1/2}$ = $\{795 / 680\}^{1/2}$ = $\{1.169\}^{1/2}$ = 1.081.




A Graph of Sieve Analysis of Soil Samples
100
50
0
% Finer Passing
0
200
400
600
800
1000
Diameter of Sieve (Um)
Series1

4.2. DISCUSSION OF RESULTS

The length of the road section used for the vehicle runs is L = 100m and width = 3.6 for the single lane road. This, the area of the road section is $A = 3.6 \times 100 = 360m^2$.

The dimension the paper size (A_1) are 762mm and 508mm. the paper were land on both sides of the road thereby making the collection of dust to be more efficient and avoid loss.

The average soil lost by those standard vehicles under the conditions earlier mentioned was found to be 214.20 / 37 = 5.78g in 100m length of the road. Therefore, it will be expected that in every kilometer on this road about 57.8g will be lost each day per passing of five standard vehicles especially at the very dry seasons. Precisely February - mid April of the year

From the PCU calculations the traffic density of the road ranges from 20 – 60 vehicles.

Thus we should expert to have a total soil loss of about 3468g (60 vehicles x 57.8g) daily.

The Atmospheric / Environmental and soil conditions are of standard values and they vary from point to point but those we used are basically taken from a reference point and other measured on experimental site.

The vehicle runs were done during the most serious period of dry seasons (February – mid April). The vehicle characteristics, soil and Atmospheric / Environmental condition give rise to dust liberation on unpaved road surfaces. Thus, emphases were made on vehicle characteristics since they could be altered.

The silt load of dust from the sieve analysis table was found to be 16.3%. It should be noted that as the speed increases, surface decreases leading to reduction of the force dislodging the soil particles, whereas dust particles movement would be increasing. It can be stated that speed is important in vehicle characteristics.

This can be seen from the graph that at a certain speed, the dust emission rate by each vehicle remains the same.

Also, if the vehicles remain in its static and mean position there will be no dust emission. Hence, the vehicle has no relationship with dust emission on unpaved roads if there is no motion / speed.

From the soil analysis, the dusts collected contain mostly sand clay, sandy clay loam and laterite. That is why they are easily dislodged and generated as dust. The fine particle collected ranges between 0.063mm – 6mm while silt loading of the soil particle from the sieve analysis table is given as (61.05 +55.84) = (116.89 / 716.43) x 100 = 16.3%.

The moisture content is 32% on the liquid limit test of 45.2% and plastic limit of 17.5% with a plastic index of 27.7% which is not too suitable for the soil use on road materials.

The best PI for road purpose is given to between (19 – 26%) and PI above 26% is not good for road purpose.

By these analyses, dust emission on the road surface can be linked to this soil test as above.

However, from this toad section about 32% of soil is expected to be lost given the above condition daily.

The result to an immediate need for regravelling, leveling, stabilizing and to perfect it paving to safe occurrence of dust emission, surface irregularity, pot – holes and other hazards effects.

No test was done on road dust suppressants but the ones provided have proofed effective adequate and suitable.

4.2.1 MATERIAL LOST FROM ROAD SURFACE

The materials from unpaved road are majorly dust and nearly all the airborne fine materials discharged from the road during the trials fell within 7m of the road edge and 60% fell within 2.5m, since materials lost were collected from both sides of the roads. The actual distribution of the

discharged materials in relation to its distance is in agreement with work done by handy and in agreement with Jones (1984).

However, the wind speed varies, but an average, the above is deal and there have been relatively few attempts in the past to determine accurately the amount of air borne fine dislodged by traffic on unpaved roads. The periods of observation were from 8.00am – 4.00pm, with traffic levels monitored.

Later materials lost from the unpaved road were returned on the British Standard (BS) sieve. Generally material lost was also dependent on the Environmental parameters while other factors are constant.

4.2.2. EFFECT OF VEHICLE CHARACTERISTICS

The reason for the differences in dust (material lost) for different vehicle at the same speed is because of the varying characteristics and physical properties of vehicles. These properties affects emission rate in number of different ways same of the properties taken into consideration are:-

Difference in tyre sizes resulting in different contact area between tyre and road surface, the spectrum of wheel loading affecting the point load on

the road, the Aerodynamics of the under side of each vehicle types and speed.

The Aerodynamics parameter is thought to exert a significant influence on the distribution of fines disturbed by the wheels. One hypothesis is that some of the disturbed fine materials will not be ejected from the road but will remain temporarily in suspension before settling back on to the road. The larger the area between the ground and the vehicle underbody, the more room there is for suspended materials to be constrained beneath the vehicle.

The Nissan blue bird wagon car, which had the lowest clearance of some 0.23m, was responsible for the higher rate of loss of fines at the lowest speed i.e. 10Km/hr. this compared to the tractor which had a clearance of 0.52m and a lower rate of materials loss. Results show that the Peugeot 504 car also has higher loss than both of these, but the heavy loading and great tyre contact area could have caused this.

After series of trial, in all cases the Peugeot 504 was the vehicle generating the most dust. This must stem from Aerodynamics of the underbody and the rear of the vehicle. The observation made by following vehicle on adjacent roads noted the presence of eddy currents generating dust clouds in the area of the wheel and the underbody. Also traffic

generated eddy current created turbulence around the rear of vehicles which considerably affected the emission and distribution of exhaust gases.

The total weight of the vehicle determines the total pressure or force per unit area acting on the soil / road surface. Due to the soil characteristics, the road surface responds differently at each different section of the different weight exerted by the vehicles.

Thus, the higher or greater the weight, the greater the pressure and soil breaking force leading to the high emission of fine particles. The reverse is also the case when the weight is very light or low. The vehicle speed forms and creates the velocity known as the threshold velocity responsible for initiation of dust movement. The emitted soil particles are able to reach the point of collection as a result of vehicle speed and it is also dependent of the wind speed.

The greater the contact area, the greater the particle of soil being broken. Thus, large surface contact area will be expected to give fine emission or otherwise.

4.2.3. EFFECTS OF ENVIRONMENTAL AND ATMOSPHERIC CONDITIONS

The evidence of the Atmosphere and Environmental effects and parameters recorded in this research. The evidence suggested a link between

the power, mass or amount and velocity of emission of particles or road surface given any selection of the road subjected to the above effects. The emission of dust depends on environmental and atmospheric condition given that other parameters and effects to be constant. The parameters, which include: temperature, solar radiation (sunshine), relative humidity, wind speed and direction, latitude (location) etc.

Temperature has a direct impact on the soil particle by reducing the moisture content of the soil, reducing the moisture content of the soil, reducing the soil particle weight and reducing soil binding force holding the soil particle together. This high temperature enhances high temperature enhances high emission of force particles on unpaved road surface or otherwise. The temperature readings were taken on the field using a digital temperature display recorder, which is sensitive to a slight change in temperature of the area of research (case study).

Solar radiation has an indirect effect because it only contributes mainly and is solely responsible for the temperature changes. The temperature in the morning hours is how thus emission is low and in high radiation hours of afternoon and early hours of the evening radiation is high temperature is high as well as emission of fine particles. The instrument used in recording the sun radiation is called Gun blanner or Sunshine recorder. It makes a

cylindrical bulb, the glass which makes of card, which absorb heat and got burnt and the rate of burnt of the card reading were taken on the graduated scale. The value for sun radiation are gotten from standard source (MINNA AIRPORT).

Moisture content was recorded at the site of experiment using digital relative humidity recorder.

Wind speed contributor to the initiation of movement of the dislodged fine. The wind speed parameter is gotten using the estimation method by the estimated values from beautiful scale, with various forces of wind speed which are noted in knot. The speeds vary with the weather condition and taking note of the category the speed fell into. At the experimental site it was found to be fresh breeze, effect of breeze, which has the corresponding value between (8 – 12). The wind direction is similar in calibration i.e. its shows the direction from which the wind is blowing which is expressed in degree, and was measured clockwise from the geographical north, and assessed with the use of a freely turning wind vane while the speed is recorded with an anemometer.

The wind effect however determines the distance of dislodged soil particle within the section of the unpaved road and the road edges.

4.2.4. WIND EROSION FORCES, DUST MOVEMENT AND DEPOSITION

Wind erosion becomes serious problem when a dry soil blows the vulnerable regions where we have a low means annual rainfall particularly less than about 250 or 300mm.

The initiation movement of wind erosion force occurs when turbulence and velocity of the wind bring about soil movement. The minimum velocity of the wind bring about soil movement by direct action of the wind is called the fluid threshold velocity. The minimum velocity required to initiate movement from the impact of soil particles carried by salutation.

Transportation is quite variable in velocity and direction that result in gusts with eddies and cross currents which lift and transport soil. The quantity of soil moved varies as the cube of the excess wind velocity over and above the constant threshold velocity, direct as the square toot of the particle and increase with the gradation of the soil.

Deposition of sediments occurs when the gravitational forces is greater than the forces holding the particles in the air. For example when the wind current carrying the sand meets an obstacle its velocity is reduced and dust is deposited.

The movement of soil particle s by creep shows that the grain particles (0.5 to 2mm) are pushed by wind force and by other particles moving with wind. The speed at which the rolling of soil particles along the surface is effected may be calculated from the equation $V^2 / g\ d = a + b/d$ (for part soil particle between 0.1 – 6mm) in size

$a = 14, B = 0.006$

4.3. DUST AND WIND EROSION CONTROL ON ROADS AND AGRICULTURAL LANDS (EFFECT OF DUST ON VEGETATION, BUILDING AND PEOPLE)

EFFECTS OF DUST ON VEGETATION ALONG THE UNPAVED ROAD

Vegetation along the unpaved road to Kampala village is deeply affected by emission of dust on an unpaved road. The major problem identified in this research is that particle of dust settles on crops and plant which automatically add to the processing cost of that crop or it makes crops unattractive and reduce their economic and market values. However, the vehicle characteristics interacting on the road surfaces affect loss of materials and its also depends on the nature of the soil. Considering the

Environmental factor like, Temperature, Pressure Relative Humidity, Visibility and Obscurity of the weather, some suspended dust materials on vegetation in the area are carried by wind. Research has proved that the major source and constituents of dust include nature of soil particle, Automobile Exhaust Emission, Tyre Wear, Metal from corrosion (of metal parts), Cement particles from building of these, soil is about 77% of dust.

FIG. 6 FIAT 666 MODEL TRACTOR SHOWING THE 100m LENGTH OF UNPAVED ROAD.

Fig.7 LEFT VIEW OF NISSAN WAGON CAR VECHILE RUN

Fig.8 RIGHT VIEW OF NISSAN WAGON CAR VECHILE RUN

FIG.9 VIEW OF VEGETATION BEFORE VECHILE RUN

FIG.10 VIEW OF VEGETATION AFTER VECHILE RUN

FIG.11 COLLECTED DUST PARTICLES

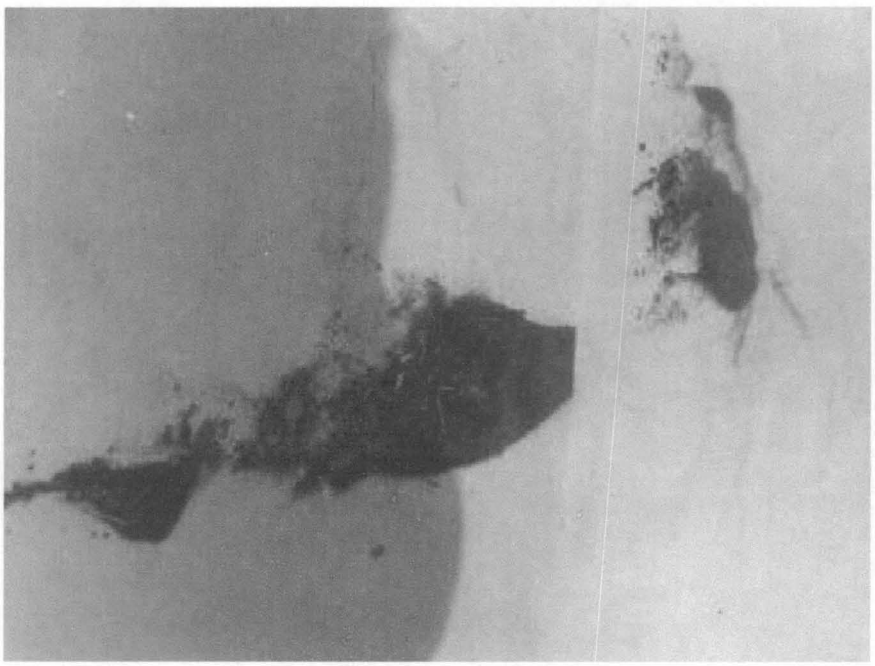
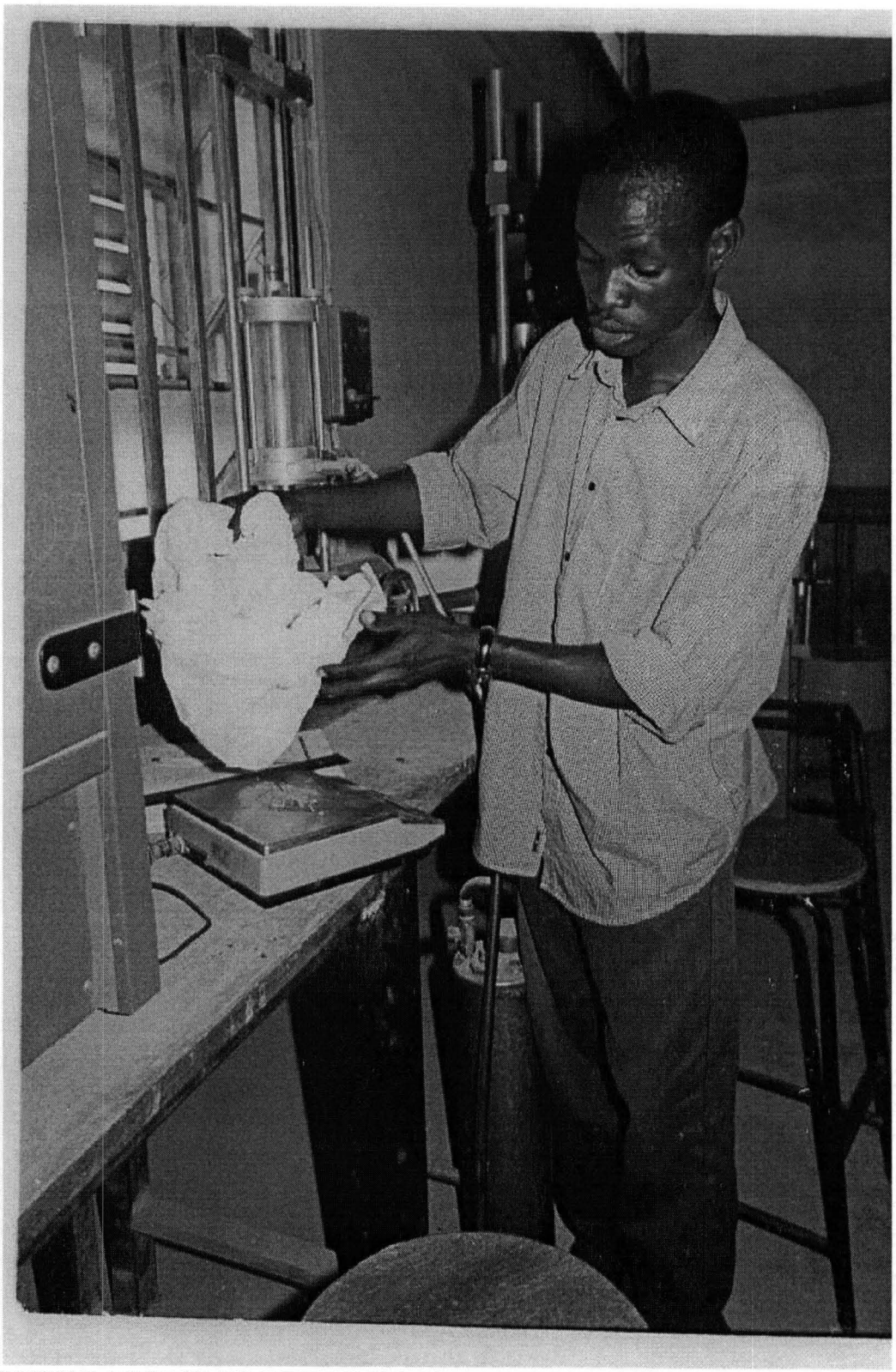


FIG.12 DUST PARTICLES COLLECTED ON A_1 PAPER SIZE



G. 13 DUST PARTICLES BEING WEIGHED AT LABORATORY USING DIGITAL ELECTRO-WEIGHING MACHINE

EFFECT OF DUST OVER THE TRANSPIRATORY NATURE OF LEAFS / PLANT

As unpaved road could be seen mostly in the Rural areas, some of the dust particles emitted during the passage of vehicle are deposited on the leafs of the roadside plants and crops. The dust emission affect the radiant energy exchange between the leaf and environmental and this causing the leaf to exchange long and short wave radiation with the adjacent soil and plant surfaces so as to have more complex energy exchange environment virtually the only sources of radiation are the sun and the sky, but if the leaf is inclined or particularly shaded significant contribution may be received by transmission and reflection from other surfaces, particularly adjacent leafs and soil. It also influences its Albedo (α) and transmission characteristics.

Neglecting heat storage in the leafs and photosynthesis constitutes the energy supply available for and dissipated by transpiration. When dusts cover the stomata opening of a leaf, transpiration is virtually zero due to stomata heat transfer and re – radiation. Transpiration from plant leafs involves water vapour transfer along a concentration gradient from the evaporating surface within the leaf to the natural leaf surface and then from leaf surface to bulk air.

In Agriculture, Dust particles settles on crops to disturb and resist water vapour transport within the leaf, between the evaporation sites and the stomata pores, which varies with the effective path length from different cells. The nearest cells to the stomata pores has the fastest evaporation and the distance for travel occurs in thick leaves and in those leaves in which the stomata are located on only one surface.

The settlement of dust particles on the leaves reduces stomata aperture by 50% but caused a 25% rise in stomata diffuse resistance. The primary factor controlling stomata aperture appears to be intercellular space, CO_2 concentration. Bellow a certain intercellular space, CO_2 concentration, which varies between species and appears to be affected by factors such as water stress, opening movements are initiated. The deposition of dust particles in the leaves and other vegetation will make the degree of opening or closing of the stomata which follows depends on the magnitude of the concentration change.

Regardless of the actual mechanism of the CO_2 control system it is clears that intercellular CO_2 concentration exercises sensitive and effective control over stomata aperture and that a flow of energy is required, at least for opening movements, since metabolic inhibitors can affectively prevent opening.

4.3.1. STABILIZED ROAD SURFACE

The major types of remedial treatment used for dealing with dust problems on unpaved roads are follows.

a. Application of a bituminous seal.
b. Coating with deliquescent salts.
c. Application of waste sulphur liquors.
d. Application of oiled gravels.
e. Admixtures of various local material such as molasses, bamboo, palm oil, vegetable oil, animal fats, lime, charcoal and many others.
f. Addition of water.

All of these treatments with the exception of the bituminous seal are temporary solutions. Frequently they need to be applied several times a year. Apart from the use of local materials, they are also expensive.

Stabilizing road surface is majorly surfacing built by combining soil material or by adding calcium or sodium chloride or certain organic compounds to the material or its surface. Not included in this classification are asphalt, stabilized layers where the surface is protected by a seal coat.

Proper and adequate addition of soil stabilizers increase soil resistance to destructive weather condition by binding the dust material together on the road surface, reducing soil shrinkage4 and swelling, making the soil to be

water proof less permeable to moisture. to control the dust, the primary aim is to stabilize the road surface, road stabilizing has the advantages of controlling dust, increase vehicle efficient, high productivity, low accident rate, prolong the life span of vehicle, reduce any physical hazard etc.

Other stabilizing materials used to control dust on this unpaved road surface are: Geotextile (fabric) application and application of pennzsuppres. The pennzsuppres ® D is proved to be move efficient in controlling dust on remedial bases.

The table below shows the soil stabilizing materials use in road dust control.

Table VI : Typical Application and uses of dust fabrics

Application	Use
Drain filter	Trench, drains, base course etc.
Subgrade stabilization light heavy	Parking lot pavement, airport pavement, haul road, storage yard, rail roads.
Reinforcement light heavy	Low full foundation, low retaining walls, high embarkment, high retaining walls
Erosion control light medium	Ditch Armour, culvert outlet protection. Small medium wave protection.
Heavy	Large wave protection

Site fence	Construction site
Reflection crack control	Asphalt overlays asphalt pavement over cement stabilized bases canal lining repair.
Drainage foundation	Consolidation Embarkment consolidation

able VII: The combination of the stabilizers may be required, through one would probably predominate

Trade name	Description	Application rate. litre / m^2
Aero spray 70	Polyvinyl acetate diluted 1 to 20 of water	2.26
Surfaseal	Trade name diluted 1 to 20 of water	1.50
Petroset sB	Biticiddne styrene rubber and resin in oil emulsion diluted 1 to 20 of water	4.52
Conerax	Petroleum resin diluted 1 to 14 of water	4.52
Dresinate DS – 60w80F	Thermoplastic resin diluted 1 to 9 of water	4.52
Paracol 1461	Wax thermoplastic resin diluted 1 to 9 of water	4.52
Terakrete	Vinyl acetate copolymer diluted 1 to 16 of water	2.26

Dust control oil	Petroleum resin	1.13
Dust stop	Acryylonite butiadene styrene copolymer diluted 1 to 20 of water	2.26
Faramine 99 – 194	Urea formaldehyde resin diluted by 40 percent water	1.13
Norlig 41 + F 125	Combination of lignin sulphate and sodfium methylate diluted 1:4 and 1: 4of water respectively	
Curaol A.E	Polymerdipersium, diluted 1 to 6 of water	4.52
Dust bond 100	Lignin sulphate and sodium methylate	4.52
Redicate E – 52	Cationic asphalt emulsion	10.45

4.3.2. MECHANICAL APPLICATION TO IMPROVE UNPAVED ROADS

Some of machine used to improve unpaved road with respect to the soil materials with poor Engineering which are unable to withstand the loads and other characteristics of the vehicle and the atmosphere are CAT D8 Dozer, CAT 612 Scraper, CAT 130G Grader, CAT 950 loader. These

machine, if properly and efficiently used to work on the unpaved road surface dust emulsion will be controlled to a bearest minimum.

4.4. KAMPALA AND ITS ENVIRONS

The unpaved road leading to Kampala village other villages serves as the major road network. There are 19 villages in the whole of Kampala. These are;

1. Kampala.
2. Dnagni.
3. Poipoi.
4. Gusasa
5. Napan Kuti
6. Lubo
7. Dama
8. Komapi
9. Lebe
10. Fyako
11. Kwayi
12. Gbutu
13. Dinpasi

14.Lubupi

15.Kuyi

16.Kamakaka

17.Kwaiko

18.Bangu

19.Bako

Kampala is initially called Bako village with the district head at Kampala.

4.4. ECONOMIC IMPORTANCE OF THE UNPAVED ROAD LEADING TO KAMPALA VILLAGE AND ITS ENVIRONS

Based on the survey work carried out, the nature of the road has made it uneasy for vehicle to ply the village constantly but on market days. The traffic density increases ranging from 40 – 60 vehicles per day (more details shown on PCU calculation). Majorly the nearest market to the village is Beji that is 12Km away while other market are Minna, Paiko, Kasuagwabe, which are 17Km, 32Km and 17Km respectively away from the village. Few vehicles that do ply charge with the range from ₦2400-₦2600 per full load of pick-up van to the nearest market.

An average farmer cultivates 30 tonnes of yam annually and the area of cultivation per farmer ranges from 2 – 3 hectares of land (fragmented

farm land). The cost of transportation of farm produce to Beji market is relatively low compared to other market patronized by the villagers.

Some villagers, who could not afford the fare charge by vehicle, use motorcycle to convey their produce to the Market which ranges from 40 – 70Kg of Agric produce per market day. Sometimes the villagers choose to carry their wares on their head and walk through the unpaved road towards the main road (Minna – Zungeru road), which is 3Km distance, just to reduce the cost of transportation to the nearest market to about 75% of the total charged.

The market days are Beji (Wednesday), Paiko (Friday), Minna and Kaswuagwabe (Saturday). The roads leading to these markets are motorable for smooth Farm Transportation. Economically Kampala village and its environs have a vast opportunity and potential to be fully industrialized. The road gives a sense of timelessness, helping resident's connect with the other path and carriage roads network. Although narrow and bordered by little vegetation along the road preservation of the unpaved nature is very important, this if improved or paved, it will make life more comfortable for the people.

4.4.1. THE POPULATION AND THE INDUSTRIALIZATION PROSPECT OF KAMPALA VILLAGE AND ITS ENVIRONS

The total population of all the 19 villages ranges from 900 – 1500 people based on the data collected and information supplied. The lateritic nature of the soil on the unpaved road leading to the village which is grade C laterite makes more dust to be emitted than grade A and B types. The materials are loosely packed with minimum CALIFORNIA BEARING RATIO (CBR).

Taking Dnagui village as case study where SHEA BUTTER tree are widely grown, this could be further developed by sitting a SHEA BUTTER oil processing plant industry around the village since there is available raw materials for production and thus minimize the wastage of this produce during its season of cultivation. By this, more people would be employed (direct/indirect labour). Thereby reducing the poverty level, rate of migration to the city and improving the standard of living of the people.

Also in Kampala village where mango fruit are produced to about 3000Kg (3 tonnes) per farmer in a season, fruit juice extracting plant industry could located in that village using mango fruits as a source of raw materials.

Industrialization will also usher in various basic social amenities like Pipe Borne Water, Electricity Supply, Primary Health Care Centers, Schools, Clubs and Reservation Centers, Security / Crime Control Centers which they have been deprived of. Presently there are 2 primary schools in the whole of the villages and there after the pupil are forced to look for secondary school education by trekking about 4Km away from their village. The road is been maintained by the communities' efforts although owned by the Local Authority (Local Government), if privates' initiatives are allowed to join efforts and resources together with the little from government, Kampala and its environs will have a better road network and fully industrialized.

CHAPTER FIVE

5.0. CONCLUSION AND RECOMMENDATION

Emphatically, dust had been explained as a finely powdered and minute earth particle of mineral and plant materials lying on any material on the earth surface and some suspended in the atmosphere. The dust so talked about has about 78% of soil as the highest constituent. While unpaved road that is made of Natural Earth Materials and whose foundation and wearing surface are composed of natural soil materials. Due to Vehicle interaction on these roads, dust is generated and the dust is partly suspended in the atmosphere, also some settled on any matter on the earth surface.

The effects of dust are on alarming stage on Global warning. Dust are also emitted from other sources including desert storm, mining activities, building and farming activities and vehicle interaction on unpaved roads.

The dangerous effects of dust from unpaved road surface include the following; Environmental pollution, increase Cost of Agricultural production, Increase cost of Vehicle Maintenance, Increase Health Problems (Constant Sneezing, Catarrh, Running Nose, Whooping Cough, Bronchitis etc). To determine how dust is been liberated and its effects on People, Crops, Vegetation, and Animal, Homes and the Environment at large.

However, understanding the potential of both vehicle and the unpaved road surface to emit dust can help improve vehicle efficiency, reduce maintenance cost, safe guard the environment as well as protect life generally for Man, Animal and Plants and increase natural standard of living. That is why a section of the unpaved road was chosen as experimental site and the experiment conducted in the dry season to ensure maximum dust emission (Good Result.) It must be known that Dust is emitted by all vehicles no matter the capacity and amount emitted by each varies and depends on the Vehicle Characteristics such as Weight, Speed, Aerodynamics, Maintenance Standard age and modification etc.

Dust emission also varies along the section of the road as a result of the Soil Engineering properties of the given road section as well as the atmospheric condition. Dust as a whole is related to how much silt is in the road materials, dislodging of soil materials also depends on the Soil Engineering Properties while dust movement and distance of travel is related to the individual particle Diameter and Weight.

5.1. CONCLUSION

The Aims and Objective of the project were successfully achieved i.e. quantifying the amount of dust emission on an unpaved roads the effect of dust on the people of the village, effect on vegetation along the road, health hazards dust has caused to inhabitants of the villages were achieved. Some of the information were gotten through administering of QUESTIONNAIRE to the villagers and from their verbal and written response, data and informations were extracted there in.

Also fine particles of dust settles on the surface of plants has preventing adequate and appropriate reception of sunlight by plants, reduce the rate of transpiration, disturbs the photosynthesis effect leading to poor growth and yielded. Again for respiratory purpose, inhaling above the permissible of 0 – 0.009g of dust particle will; cause serious Health Hazards as recommend by World Health Organization (WHO 2000) where over 24.47 – 214.2g of dust was generated in this 100m road section by the five vehicles after 7 passes by each. And an average 5.78g of dust particle is lost per vehicle after 7 passes on this road section, thus loss of dust annually will be far more thereby making the road surface very irregular, susceptible to erosion and disturbing vehicle manouverability. Hence, there is high need for yearly re – gravelling and stabilizing of the unpaved surfaces.

The major cause of dust on unpaved roads is Vehicle characteristics, Road materials (soil type). Environmental and Atmospheric conditions, Current Research proofed that dust-suppressing compound used are: Calcium Lignosulhpate, Magnesium Chloride of Penn Suppress D remains the best remedy of dust on unpaved road.

Finally, for a long – term operation, advantage and motorability, all unpaved roads should be made paved.

5.2. RECOMMENDATION

With no exception of anyone, we all know that Dust is a major hazardous particle to Man, Plant, Animals, Buildings, Machines, Equipment and vehicles. Vehicles users' owners should be conscious of modifications, which can contribute to dust emission. Also, they are advised to maintain a Speed limit of about 20Km/hr – 25Km/hr when they are driving on unpaved road so as to minimize the rate of dust emission.

The Federal Environmental Protection Agency (FEPA) should also give more Enlightenment and Awareness Campaign Programmes in collaboration with the Federal Road Safety Commission (FRSC) to the people so as to reduce the menace of dust emission in the Environment. Dust can be completely eradicated by making the unpaved roads paved or temporary solution for dust emission is the use of chemical suppressants. The water quality analysis indicates suppressants concentration in run off samples from the treated road surface. Also stabilizing materials such as water, charcoal, waste surplhur, oils and other locally available road stabilizing materials should be used on unpaved road surface.

Overall, as Recent statistics that, out of the 194,000 Road network nationwide 16% of the Roads are Federal Roads, 17% are State owned Roads, while 67% of Roads are Rural roads or less developed, which are

maintained by the Local Authority in charge or by the community herself, Government and other private organizations should initiate and develop programmes that will bring about development and better standard of living of the 75% of Nigerian population who are found to be Rural dwellers and farmers through stabilizing and paving the Roads.

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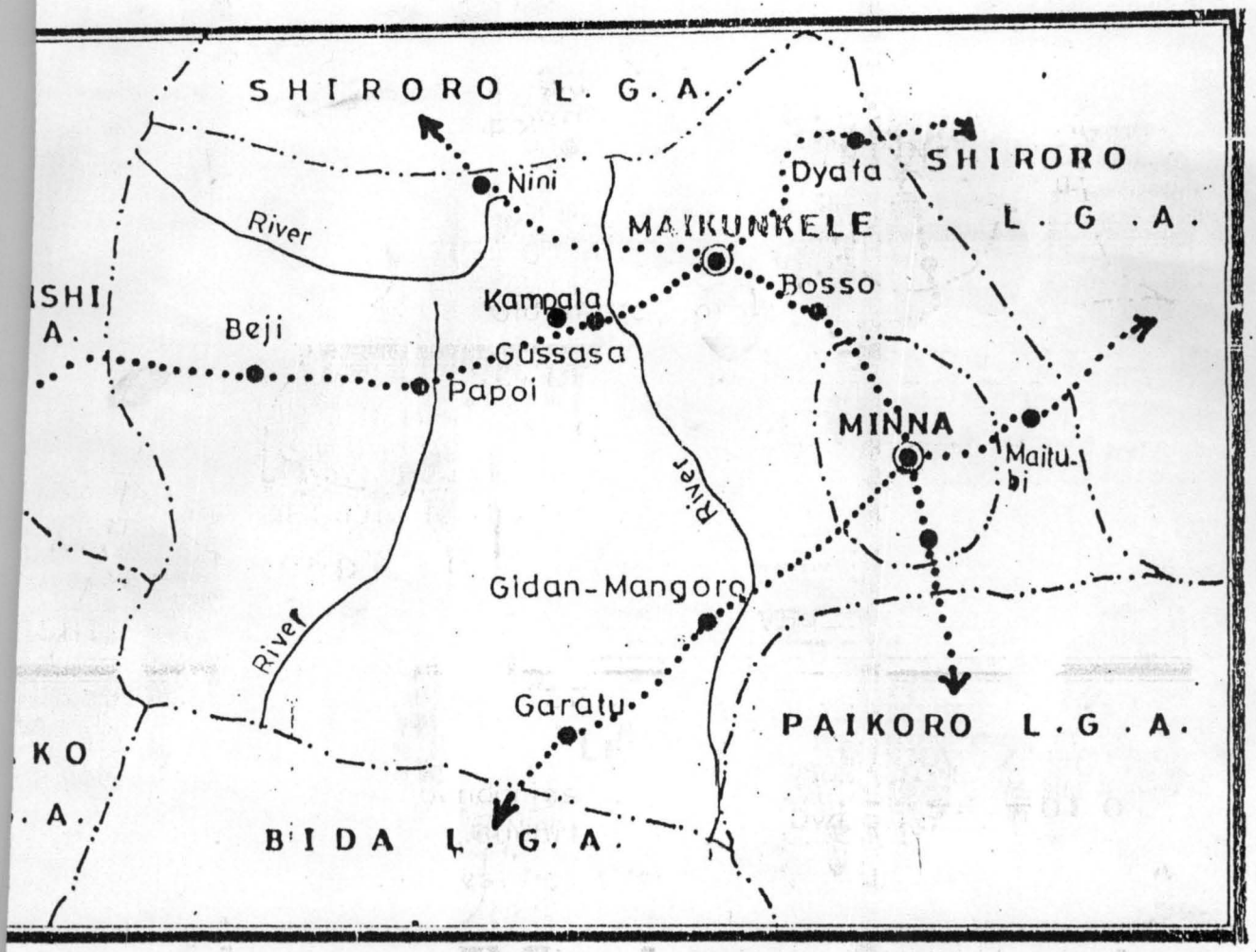

SCALE :-1:175,000

LEGEND

Local Govt. Boundaries.....

Local Govt. Headquarters..... MINNA

Towns & Villages..... Bosso

Rivers.....

FEDERAL UNIVERSITY OF TECHNOLOGY
MINNA, SCHOOL OF ENGINEERING AND
ENGINEERING TECHNOLOGY,
DEPARTMENT OF AGRICULTURAL
ENGINEERING.

A QUESTIONNAIRE ON KAMPALA VILLAGE AND ITS ENVIRONS ABOUT THE EFFECT OF DUST EMISSION ON UNPAVED ROAD LEADING THROUGH THE VILLAGES.

The reason for this questionnaire is to derive the basic necessary information for the research and fieldwork on the project tittle.

The research is carried out in partial fulfillment of the award of *bachelor's* degree *of* Engineering (B.Eng.) in Agricultural Engineering in the above named institution.

Please do answer the question and tick where appropriate. All respondents' answer shall be treated with maximum confidentiality.

OPALEYE, oluseun oladipo (99/9062EA)
Agric. Engineering dept.
F.U.T Minna.

TION A:

Name of respondent……..

L.G.A/Village……

Educational background

Primary (b) secondary(c) Above secondary (d) None

Major Occupation

farming (b)fishing (c)hunting (d)handcraft (e)trading(f)student (g) specify

er……..

Do you like the nature of the road to your village?

YES (b) NO

CTION B:

What are the crops grown in your village?

Yam (b) cassava(c) coco yam (d) sweet potato (e) mango (f)shea butter nut(g)maize (h)rice

wheat (j) millet (k)ground nut (l) specify others…….

What storage method /methods do you use for storing your crops.

Silo (b) pots trench (c) grannies and the barns (d) cribs) (e) specify

hers……

When dust settles on your crops in the storage, what method do you use to remove it?

Washing with water (b) cleaning with duster (c) specify

ers……

what are the likely illness you had through inhaling dust?

ıtery eyes (b) irritation in throat &lungs on inhalation(c) constant sneezing on inhalation

ınning nose /catarrh (e) pneumonia (f) specify

:.....

ave you been hospitalized before? (a)YES (b)NO

TIONC:

or how long were you there? (a) a day(b)a week (c) a month (d) specify

thers.....

Iow often do you have headache? (a) Daily (b)weekly(c) monthly(d) specify

›thers.....

How often do you have catarrh? (a) Daily (b) weekly(c) monthly (d) specify

other.....

Are you an asthmatic patient? (a) YES (b) NO

Do you use any protector for dust, if YES thick

Nose muff (b) eyes goggles (c) hand gloves (d) boots (e) head protector (f) specify

ers.....

. Have you had an accident along the road to your village before? (a) YES (b) NO

. How many times? (a) Once (b) twice(c) thrice (d) specify

other.....

. Do you want your road to be paved? (a) YES (b) NO

. If yes, state reason.....

. How often do people visit you from the city? (a) Once in a while (b) frequently (c) all times

(d) specify others.....