

Practical Technologies for Agricultural Development

2022 June 9th



Dr. Jiehua Chen (“JC”), Ph.D.
QED | <https://qed.ai>

Meet the Team

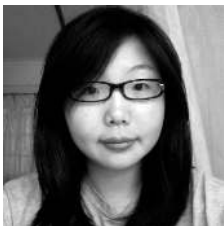
Quantitative Engineering Design | <https://qed.ai>



WHY Build data systems and AI to empower orgs in pursuit of health and agriculture SDGs (2,3,6,15)

WHO ~30 software engineers and data scientists
+ domain experts in agronomy and epidemiology

HOW Forte: technologies for challenging environments
Since 2012, has run projects in 13 countries, including NGO incorporation and local staff in Malawi



Jiehua Chen ("J.C.")

Ph.D. Stat (Stanford)
M.S. Econ (Stanford)
B.S. Math+Physics (Tsinghua)
Ex-Columbia Earth Institute



William Wu

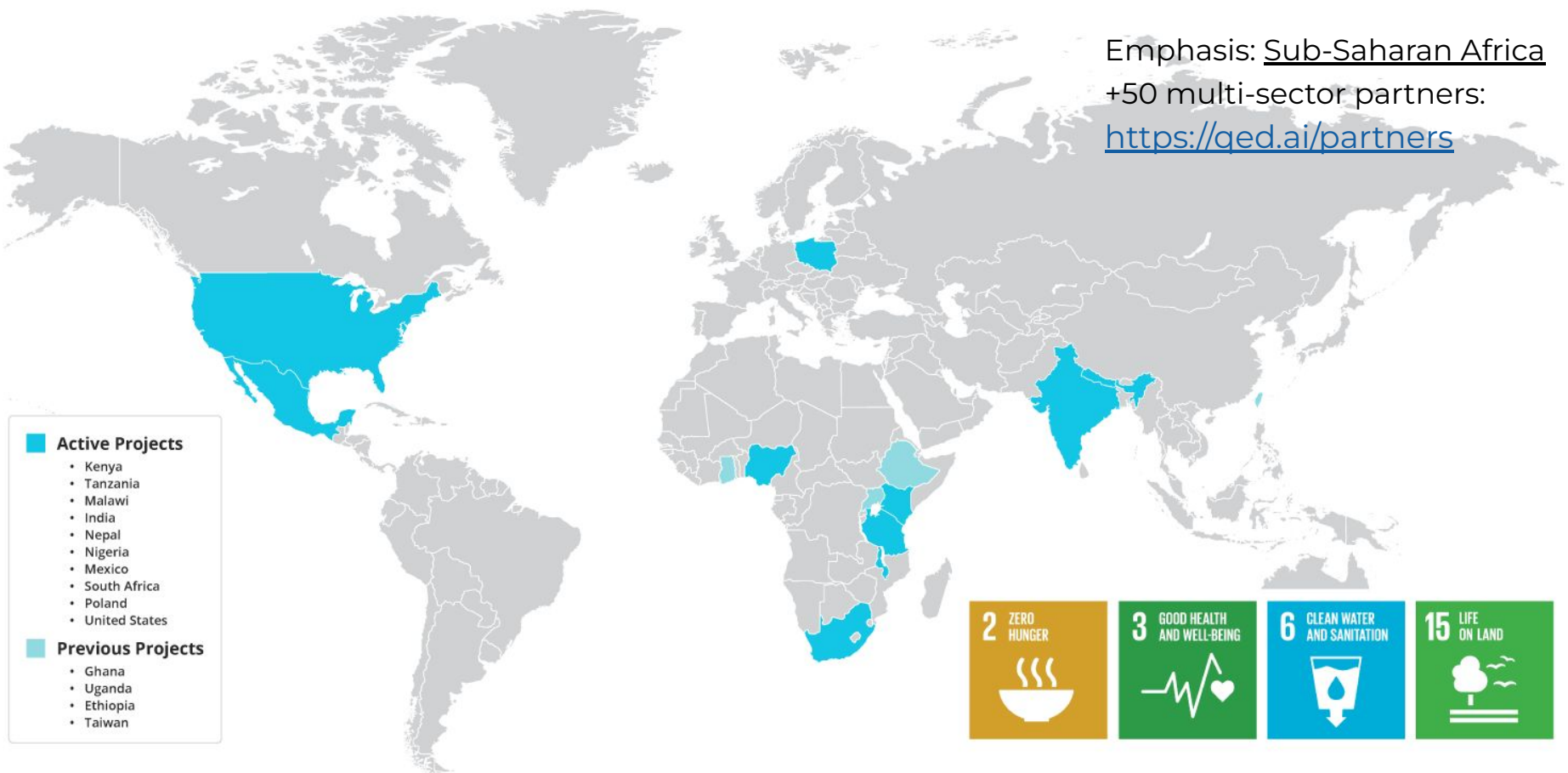
Ph.D. EE (Stanford)
M.S. Math (Stanford)
B.S. EECS (Berkeley)
Ex-NASA JPL



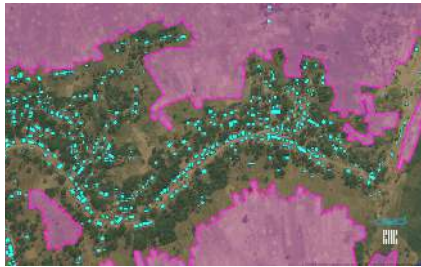
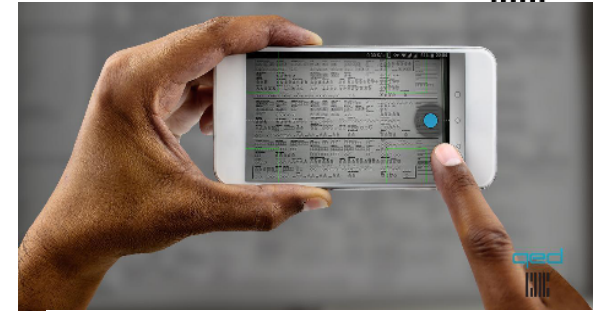
David Guerena

Ph.D. Crop and Soil
Science (Cornell)
B.S. Crop and Soil
Science (CalPoly)

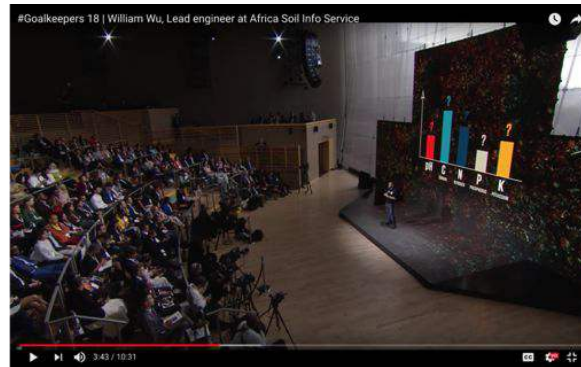
Emphasis: Sub-Saharan Africa
+50 multi-sector partners:
<https://qed.ai/partners>



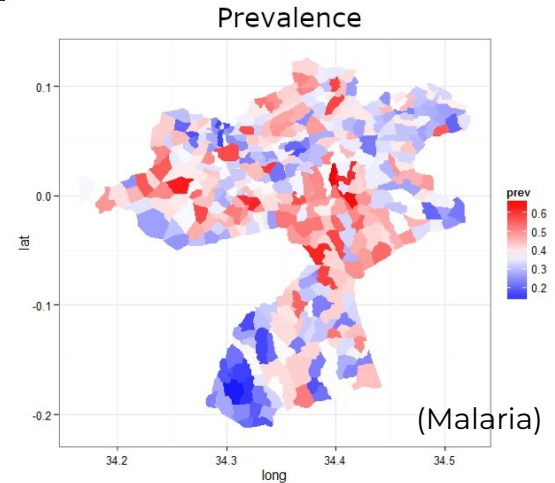
Tech Innovations To Overcome Data Scarcity



building footprints and
land cover mapping



Monitoring of soils and
crops



ScanForm: phone-scannable paper for
in-field surveillance

INSUFFICIENT DATA: AGRICULTURE



Volume of production per labor unit by classes of farming/pastoral/forestry enterprise size

Most low-income countries in sub-Saharan Africa still aren't collecting data on agricultural productivity and income, because doing so is unusually expensive and labor intensive. Working with a group of donors, U.N. agencies, and countries, our foundation is helping to ramp up efficient agricultural surveys in the countries where there are gaps, with the goal that all countries are regularly funding high-quality surveys in the next decade. This will enable them to continually adjust investments and policies based on evidence about what works.

BILL & MELINDA
GATES foundation



GOALKEEPERS

Cropland Mapping

National-Scale Cropland Mapping for Smallholder Agricultural Systems

Good spatial data is essential to inform agricultural policies, but is scarce in regions with high densities of smallholder farms. Since 2014, QED has built tools to close this gap and map land cover use at national scale. Our system combines:

1. a crowdsourcing pipeline (Geosurvey) to annotate cropland indicators in satellite imagery,
2. A.I. that makes national-scale interpolations, and
3. agronomic expertise and ground data collection.

We offer in-house pipeline execution for generating maps of croplands and buildings, or customized support for data collection both online and in the field.



Crowdsourcing



AI



Field



Maps



Nigeria: Map of *all* croplands (10m). Acc 85%, Prec 92%



Field boundary mapping R&D (Sokoto)



Nepal: All croplands, houses, and infra

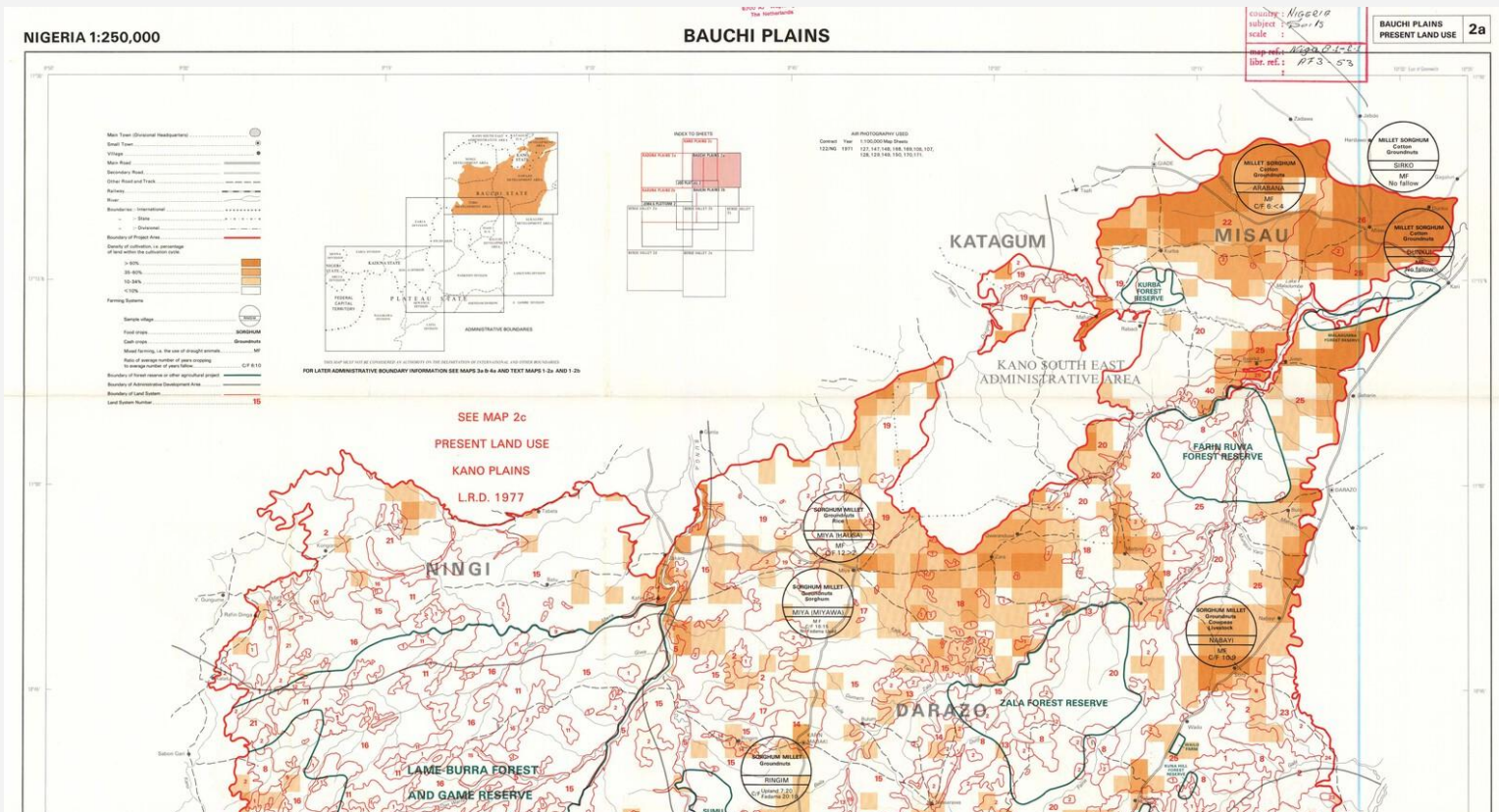
Map Examples: maps.qed.ai/map/ng_cp_preds
nsaf-geospatial.qed.ai

Geosurvey: geosurvey.qed.ai



Case Study 1: **Nigeria Cropland Mapping**

Legacy Crop Maps



Cropland Mapping





Automated Plot Boundary Mapping in Nigeria [Test]

Download layer

Nigeria QED.ai
 13.29815, 5.47055

0.3m
 15.0

QED.ai
[Copy Link](#)





Automated Plot Boundary Mapping in Nigeria [Test]

Download layer

Nigeria

QED.ai

0.3m

QED.ai

13.29815, 5.47055

15.0

[Copy Link](#)



A.I.



A.I.





Case Study 2:

Nepal Seed and Fertilizer Project (NSAF)

Where?
Buildings



maps



Where?
Buildings



maps



Where? Geospatial Strategy

- ☐ Nepal roads
- ☐ QED Building Footprint Map
- ☐ Agro Dealers



Longitude:
82.544841
Latitude:
28.390426
Zoom Level:
13

Download geojson



maps

qed



Where? Geospatial Strategy

- ☐ Nepal roads
- ☐ QED Building Footprint Map
- ☐ Agro Dealers



Longitude:
82.544841
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13

Download geojson



maps



Where? Geospatial Strategy

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Where? Geospatial Strategy

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Zoom Level:
13

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


Where? Geospatial Strategy

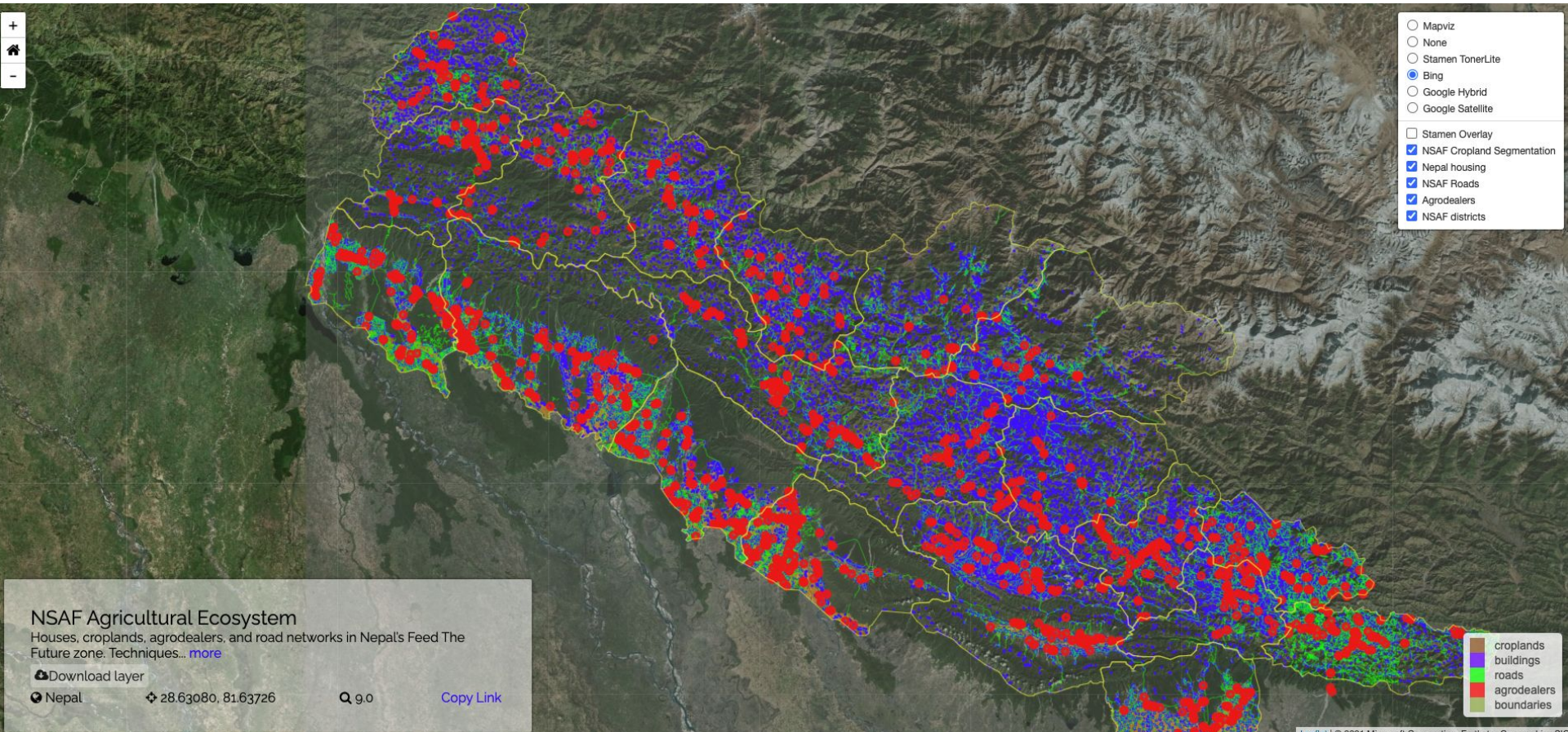
- ☒ Nepal roads
- ☒ QED Building Footprint Map
- ☒ Agro Dealers



Longitude:
82.544841
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13

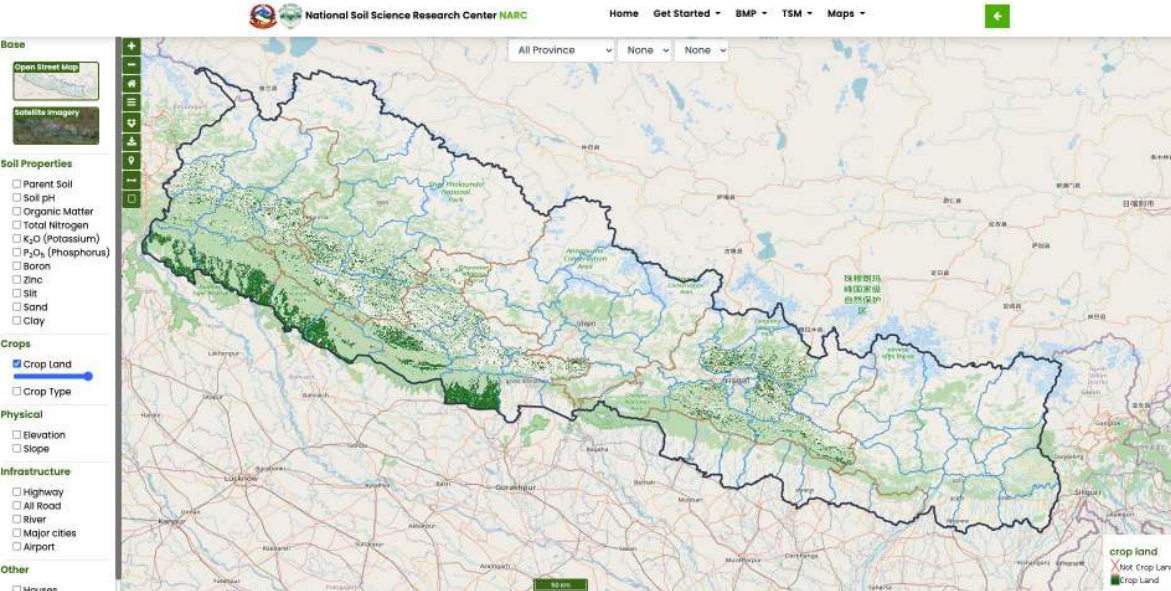
 Download geojson 





National Agricultural Policy

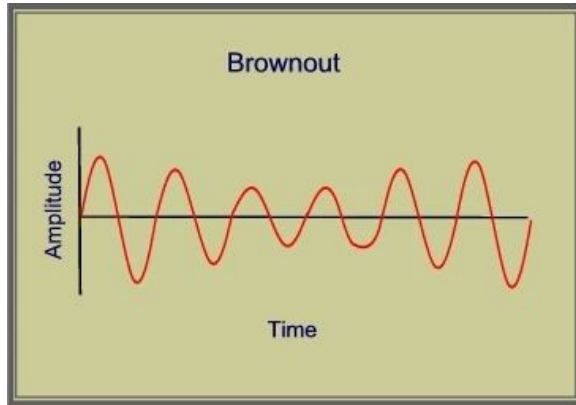
QED cropland map for Nepal officially integrated into agricultural statistics used for national fertilizer subsidy program by the Prime Minister and Minister of Agriculture



Soil and Plant Analysis

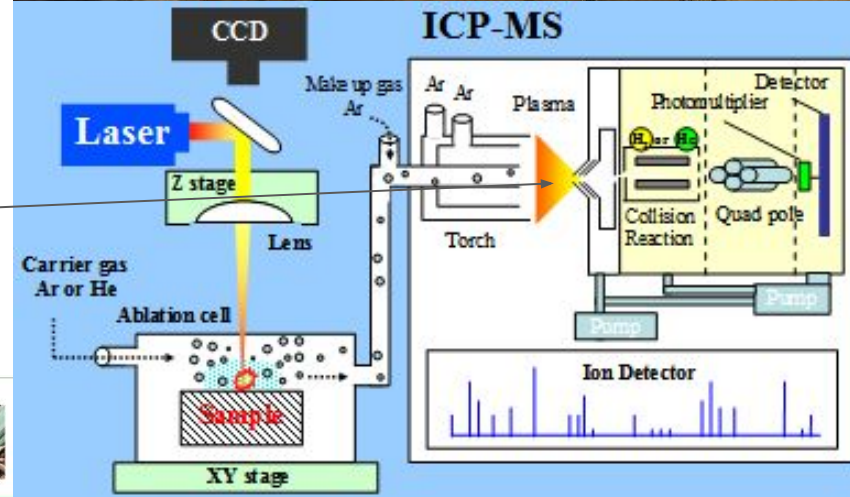
Perfect, and Unaffordable

Cost: 250,000 USD →



10000 Kelvin!

(ノ◦□◦)ノ ー





\$\$\$\$
250K



\$\$\$ 
40K

Field-to-Lab



\$
.5K?



\$
.5K?

Lab-to-Field

Sufficient, and Practical

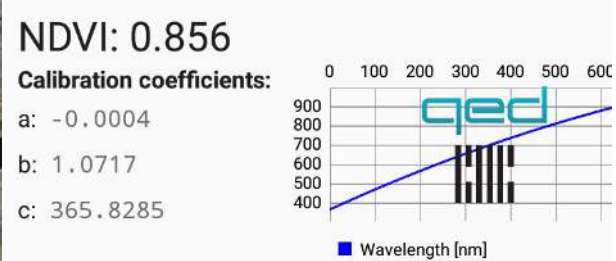
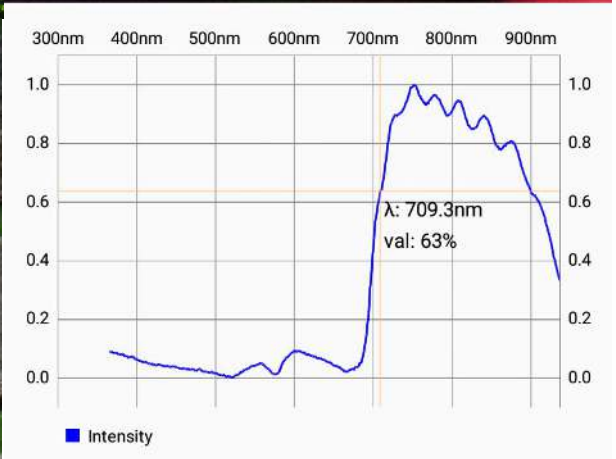
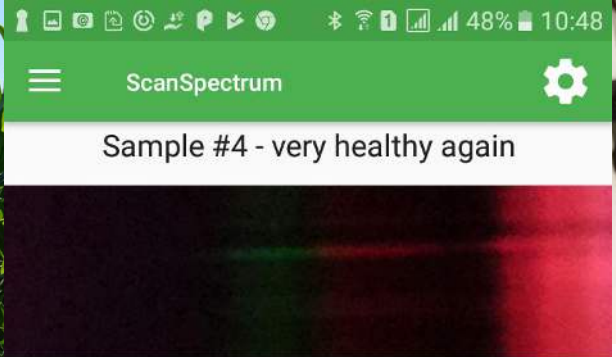


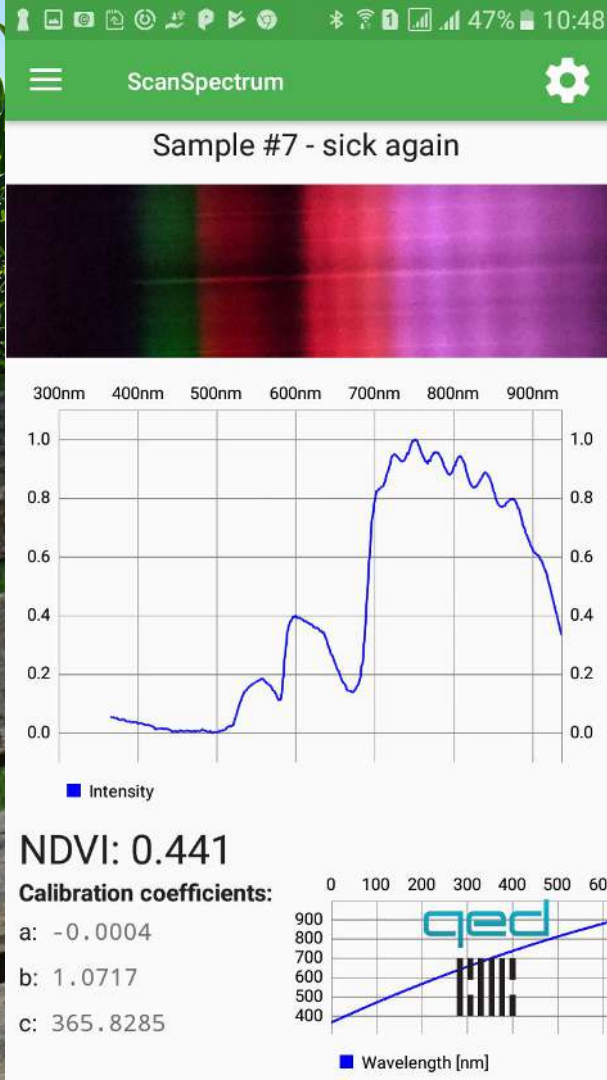
ScanSpectrum
qed.ai





HELLO
I AM...
AN EXPERT





Maize Adulteration

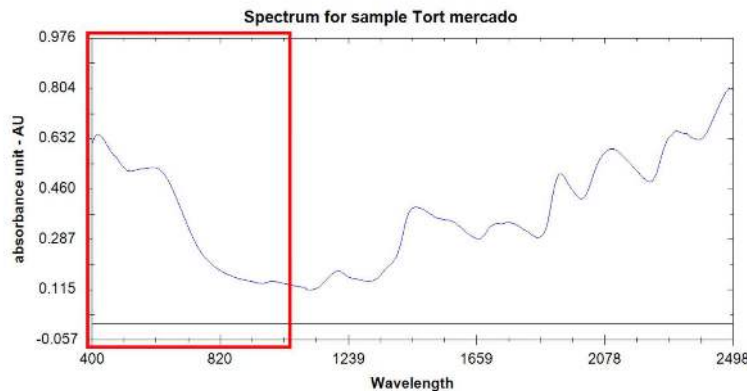
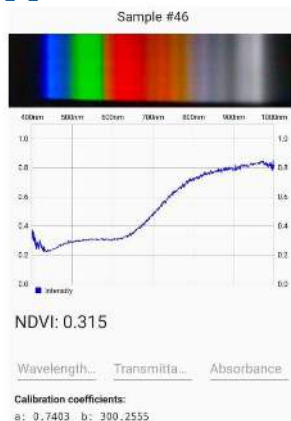


ScanSpectrum
qed.ai

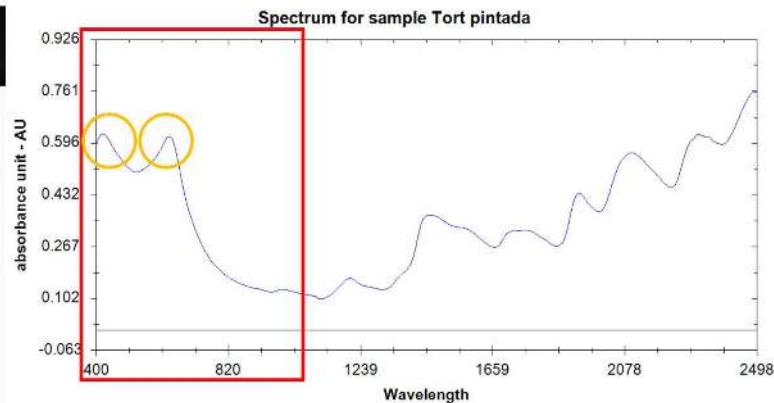
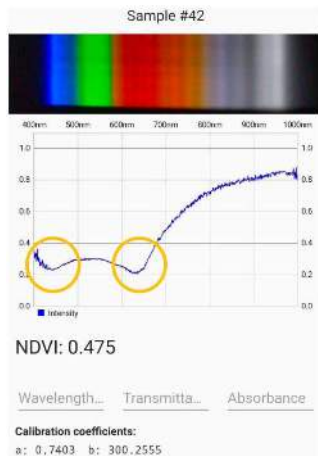
CIMMYT
International Maize and Wheat Improvement Center



Genuine Maize Flour



Fake Maize Flour



Rugged Data Collection

Advancing Market Intelligence in Africa

Tablets and Phones



- ☒ Google Hybrid
 - ☐ Offline Google Hybrid
- ☒ States
 - ☒ Regions
 - ☒ Connections
 - ☒ Hubs
 - ☒ Retailers
 - ☒ Roads



Africa
Ghana
Brong-Ahafo

Longitude: Latitude: Zoom Level:
-2.186279 07.167663 10

Town: Techiman
Shop: Waaf Agro
Owner: Kojo addo

- Borders
- Roads
- Retailers
- Hubs

Fertilizer Cost Build-Up, Ghana 2020

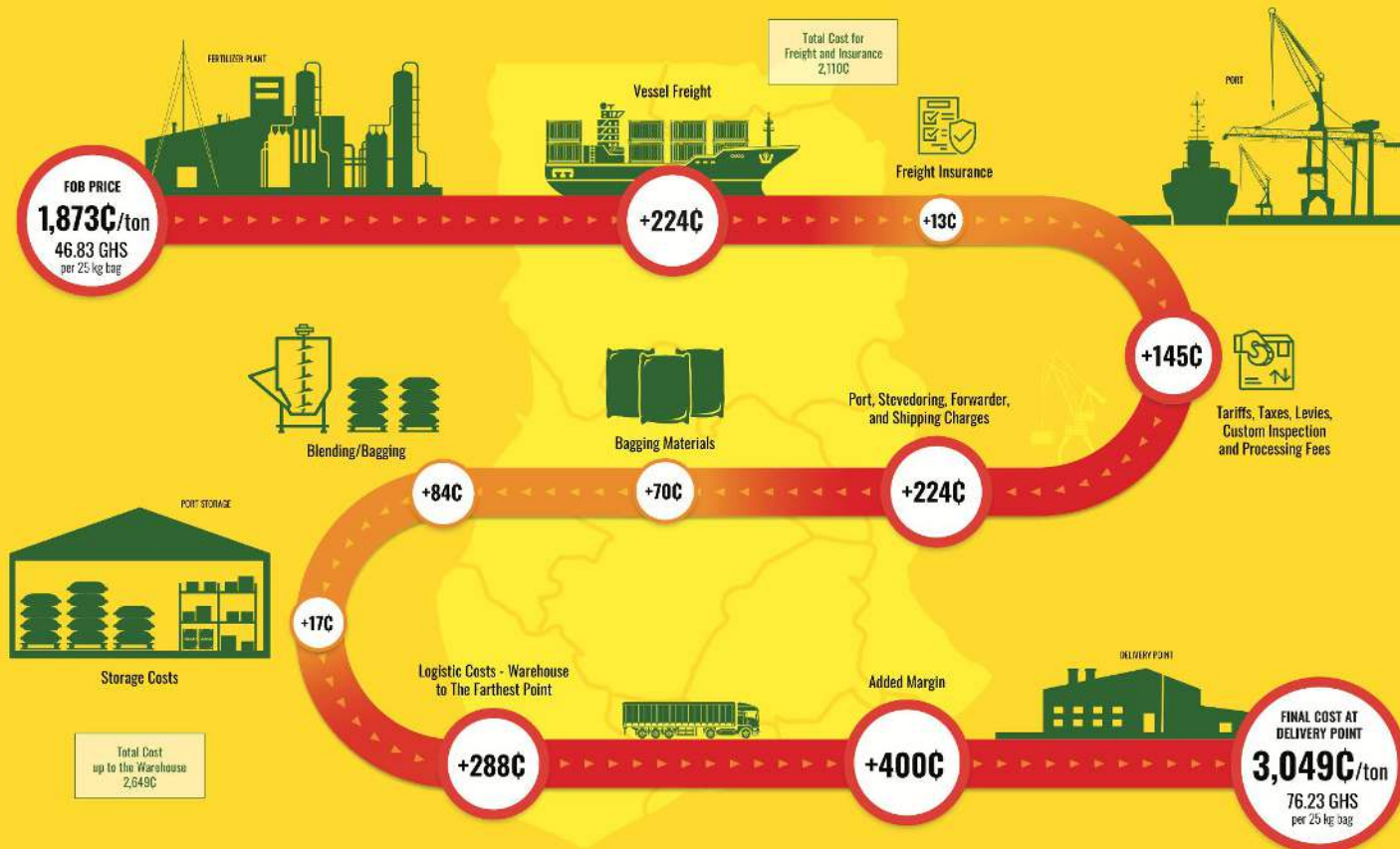
Product: NPK 11-22-21 + 5S + 0.7 Zn + 0.5 B



qed
QUANTITATIVE ENGINEERING DESIGN



African Fertilizer and
Agrochemicals Partnership
afap
Partnerships Productivity Prosperity



Scannable Paper

(a short story, followed by the application to agriculture)



Paper!

(it's everywhere ... especially in health)
(electronic systems aren't working in rural environments)



REPUBLIC OF KENYA
MINISTRY OF HEALTH

ANTENATAL CARE REGISTER

MOH- 405

County:	Sub-County:
Facility:	
MFL Code:	

POC TRI Kit Lot # 1 2 1 7 8 9 2 2 1 0 4 8 3 1 3

Date of Visit (dd/mm/yy) 22/01/19

HTS Number

Client Consented to POC TRI Yes No

Sex M F NP ☒ NP

Age

Residence

Last HIV Test Result Low L+ L- Un

Time Since Last Test

UniGold Result

Final HIV Test Result

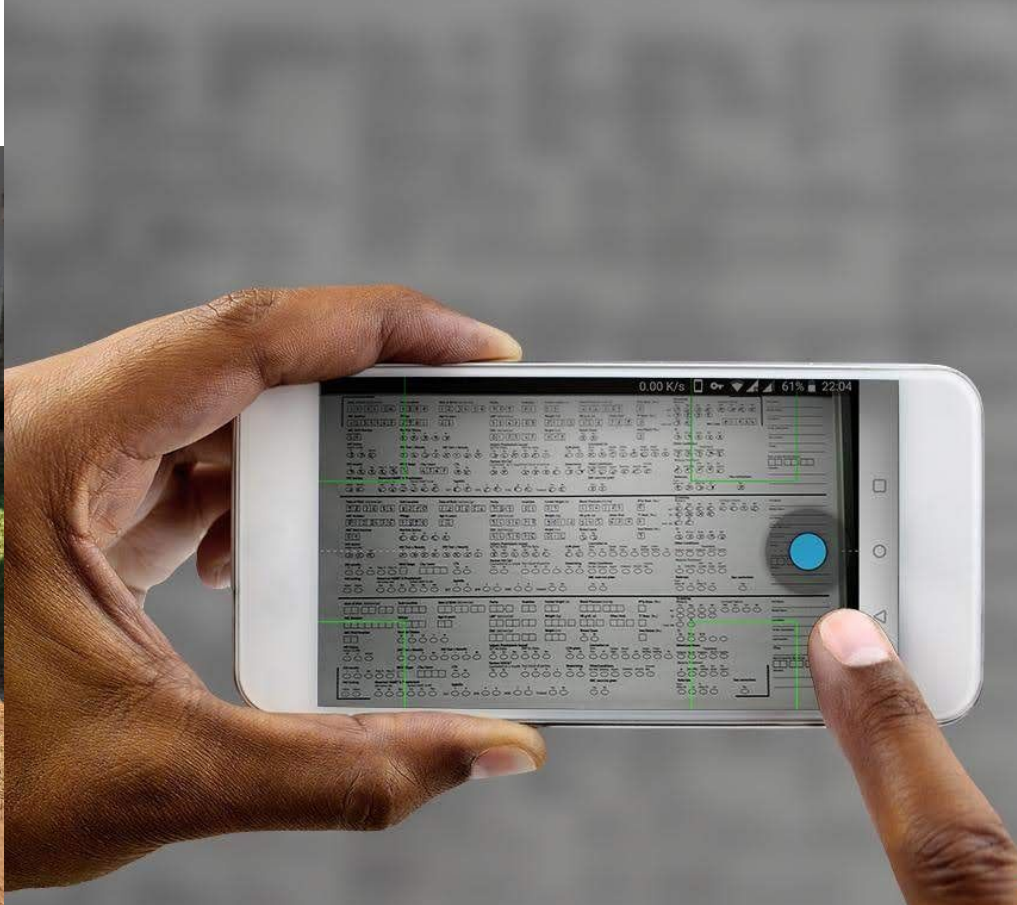
Last HIV Test Result Low L+ L- Un

Step 1
**Write on
paper.**



ScanForm
qed.ai

(note: extension agents can
also take pictures!)



Step 2 Take a picture.

Note: Typical ~125 USD phone is OK!



ScanForm
qed.ai



Cross the oval with an "X" like this. .
If no data is available, leave it blank.

Date of Visit (dd/mm/yy) 18/02/19		Sub-Location Code 0008		Date of Birth (dd/mm/yy) 06/12/97		Parity 01-0 02		Gravidae 02		Blood Pressure (mmHg) (sys/dias) 110/70		Counseled on Birth Plan Yes No		ANC Prophylaxis On ARV before 1st ANC Visit Yes No		MFL Code 13771	
ANC Number 0111218		Village Code 0008		Age in Years Fundal Height (w) 21 16		LMP (dd/mm/yy) 01/06/18		HB g/dL 1st Visit Yes No		Breast Exam Yes No		HIV Yes No		Screening Pap VIA VILI ND		MFL Code 13771	
ANC Visit No. Marital Status 03		HIV Status Before 1st ANC Yes No		HIV Testing Initial Retest Yes No		HIV Test 1 Results P I N NA Yes No		Malaria Screening Yes No		Other Conditions Hypert Diabetes Epilepsy Yes No		Prophylaxis ITN given Yes No		ANC Exercise Given Yes No		Has Corrections? Yes No	
Syphilis Screening Yes No		HIV Results P N NA Prev P Prev N Yes No		Partner HIV C&T Counseled as a couple Yes No		WHO Stage CD4 Count		Malaria Treatment AL OHA-PPD sulfate Qul (oral) Qul (parent) Other Please specify		Other Conditions Treatment Hypert Diabetes Epilepsy RTI/STI Other Please specify		Supplementation Iron Folic Vit Cal CMB Yes No		Referrals From Other HF CU Yes No		Other Parameters 1. 2. Yes No NA	

Date of Visit (dd/mm/yy) 18/02/19		Sub-Location Code 0008		Date of Birth (dd/mm/yy) 14/02/92		Parity 02-0 03		Gravidae 03		Blood Pressure (mmHg) (sys/dias) 110/70		Counseled on Birth Plan Yes No		ANC Prophylaxis On ARV before 1st ANC Visit Yes No		MFL Code 13771	
ANC Number 0190219		Village Code 0008		Age in Years Fundal Height (w) 27 24		LMP (dd/mm/yy) 01/10/18		HB g/dL 1st Visit Yes No		Breast Exam Yes No		HIV Yes No		Screening Pap VIA VILI ND		MFL Code 13771	
ANC Visit No. Marital Status 01		HIV Status Before 1st ANC Yes No		HIV Testing Initial Retest Yes No		HIV Test 1 Results P I N NA Yes No		Malaria Screening Yes No		Other Conditions Hypert Diabetes Epilepsy Yes No		Prophylaxis ITN given Yes No		ANC Exercise Given Yes No		Has Corrections? Yes No	
Syphilis Screening Yes No		HIV Results P N NA Prev P Prev N Yes No		Partner HIV C&T Counseled as a couple Yes No		WHO Stage CD4 Count		Malaria Treatment AL OHA-PPD sulfate Qul (oral) Qul (parent) Other Please specify		Other Conditions Treatment Hypert Diabetes Epilepsy RTI/STI Other Please specify		Supplementation Iron Folic Vit Cal CMB Yes No		Referrals From Other HF CU Yes No		Other Parameters 1. 2. Yes No NA	

Date of Visit (dd/mm/yy) 18/02/19		Sub-Location Code 0009		Date of Birth (dd/mm/yy) 03/11/95		Parity 03-0 04		Gravidae 04		Blood Pressure (mmHg) (sys/dias) 110/70		Counseled on Birth Plan Yes No		ANC Prophylaxis On ARV before 1st ANC Visit Yes No		MFL Code 13771	
ANC Number 02020119		Village Code 0024		Age in Years Fundal Height (w) 22 28		LMP (dd/mm/yy) 23/07/18		HB g/dL 1st Visit Yes No		Breast Exam Yes No		HIV Yes No		Screening Pap VIA VILI ND		MFL Code 13771	
ANC Visit No. Marital Status 02		HIV Status Before 1st ANC Yes No		HIV Testing Initial Retest Yes No		HIV Test 1 Results P I N NA Yes No		Malaria Screening Yes No		Other Conditions Hypert Diabetes Epilepsy Yes No		Prophylaxis ITN given Yes No		ANC Exercise Given Yes No		Has Corrections? Yes No	
Syphilis Screening Yes No		HIV Results P N NA Prev P Prev N Yes No		Partner HIV C&T Counseled as a couple Yes No		WHO Stage CD4 Count		Malaria Treatment AL OHA-PPD sulfate Qul (oral) Qul (parent) Other Please specify		Other Conditions Treatment Hypert Diabetes Epilepsy RTI/STI Other Please specify		Supplementation Iron Folic Vit Cal CMB Yes No		Referrals From Other HF CU Yes No		Other Parameters 1. 2. Yes No NA	



Step 3
Get the
data!

First Name _____
Middle Name _____
Last Name _____
Tel No. (parent/other) _____
Sub-Location Name _____

Village Name _____

Date of Next Visit (dd/mm/yy) _____

Remarks _____

Date of Visit (dd/mm/yy) **18/02/19** **Sub-Location Code** **0008** **Date of Birth** (dd/mm/yy) **06/12/97** **Parity** **01-0 02** **Gravidae** **01-0 02** **Blood Pressure** (mmHg) (sys/dias) **110/70** **Counseled on** Birth Danger Plan Signs FP **ANC Prophylaxis** On ARV Yes No NA Rev **MFL Code** **13771** **Screening** PAP VIA VLU ND **ANC Number** **0111218** **Village Code** **0008** **Age in Years** **21** **Fundal Height (w)** **16** **LMP** (dd/mm/yy) **08/18** **HB g/dl** 1st Visit **18** **Breast Exam** Yes No **Suppl. Feeding** Yes No **ANC Visit No.** **03** **Marital Status** M D W SE SI **Height (cm)** **172** **Weight (kg)** **0.92** **EDD** (dd/mm/yy) **03/19** **HB g/dl** Other Visit **18** **Fever 48h** Yes No **Infant Feeding** ITN **Other** **03/19**

Syphilis Screening RDT RPR **HIV Status** Before 1st ANC KP U Revisit **HIV Testing** Initial Retest ND **HIV Test 1 Results** P I N NA **Malaria Screening** P N ND BS P N ND **Other Conditions** Unc. Mal. Sev. Mal. Hypert. Diabetes Epilepsy **Prophylaxis** IPTp Dose (No.) NA LITN given Yes No **ANC Exercise Given** Yes No **Referrals** From Other HF CU **Has Corrections?** Yes No **Other Parameters** 1. Yes No NA 2. Yes No NA

First Name _____
Middle Name _____
Last Name _____
Tel No. (parent/other) _____
Sub-Location Name _____

Village Name _____

Date of Next Visit (dd/mm/yy) _____

Remarks _____

Date of Visit (dd/mm/yy) **18/02/19** **Sub-Location Code** **0008** **Date of Birth** (dd/mm/yy) **14/02/92** **Parity** **02-0 03** **Gravidae** **02-0 03** **Blood Pressure** (mmHg) (sys/dias) **110/70** **Counseled on** Birth Danger Plan Signs FP **ANC Prophylaxis** On ARV Yes No NA Rev **MFL Code** **13771** **Screening** PAP VIA VLU ND **ANC Number** **01190219** **Village Code** **0003** **Age in Years** **27** **Fundal Height (w)** **24** **LMP** (dd/mm/yy) **10/18** **HB g/dl** 1st Visit **18** **Breast Exam** Yes No **Suppl. Feeding** Yes No **ANC Visit No.** **01** **Marital Status** M D W SE SI **Height (cm)** **183** **Weight (kg)** **0.63** **EDD** (dd/mm/yy) **07/19** **HB g/dl** Other Visit **18** **Fever 48h** Yes No **Infant Feeding** ITN **Other** **07/19**

Syphilis Screening RDT RPR **HIV Status** Before 1st ANC KP U Revisit **HIV Testing** Initial Retest ND **HIV Test 1 Results** P I N NA **Malaria Screening** P N ND BS P N ND **Other Conditions** Unc. Mal. Sev. Mal. Hypert. Diabetes Epilepsy **Prophylaxis** IPTp Dose (No.) NA LITN given Yes No **ANC Exercise Given** Yes No **Referrals** From Other HF CU **Has Corrections?** Yes No **Other Parameters** 1. Yes No NA 2. Yes No NA

First Name _____
Middle Name _____
Last Name _____
Tel No. (parent/other) _____
Sub-Location Name _____

Village Name _____

Date of Next Visit (dd/mm/yy) _____

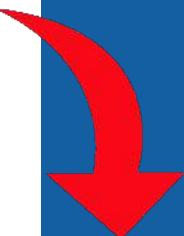
Remarks _____

Date of Visit (dd/mm/yy) **18/02/19** **Sub-Location Code** **0009** **Date of Birth** (dd/mm/yy) **03/11/95** **Parity** **03-0 04** **Gravidae** **03-0 04** **Blood Pressure** (mmHg) (sys/dias) **110/70** **Counseled on** Birth Danger Plan Signs FP **ANC Prophylaxis** On ARV Yes No NA Rev **MFL Code** **13771** **Screening** PAP VIA VLU ND **ANC Number** **02001119** **Village Code** **0024** **Age in Years** **22** **Fundal Height (w)** **28** **LMP** (dd/mm/yy) **07/18** **HB g/dl** 1st Visit **18** **Breast Exam** Yes No **Suppl. Feeding** Yes No **ANC Visit No.** **02** **Marital Status** M D W SE SI **Height (cm)** **159** **Weight (kg)** **0.56** **EDD** (dd/mm/yy) **10/19** **HB g/dl** Other Visit **18** **Fever 48h** Yes No **Infant Feeding** ITN **Other** **10/19**

Syphilis Screening RDT RPR **HIV Status** Before 1st ANC KP U Revisit **HIV Testing** Initial Retest ND **HIV Test 1 Results** P I N NA **Malaria Screening** P N ND BS P N ND **Other Conditions** Unc. Mal. Sev. Mal. Hypert. Diabetes Epilepsy **Prophylaxis** IPTp Dose (No.) NA LITN given Yes No **ANC Exercise Given** Yes No **Referrals** From Other HF CU **Has Corrections?** Yes No **Other Parameters** 1. Yes No NA 2. Yes No NA

Step 3 Get the data!

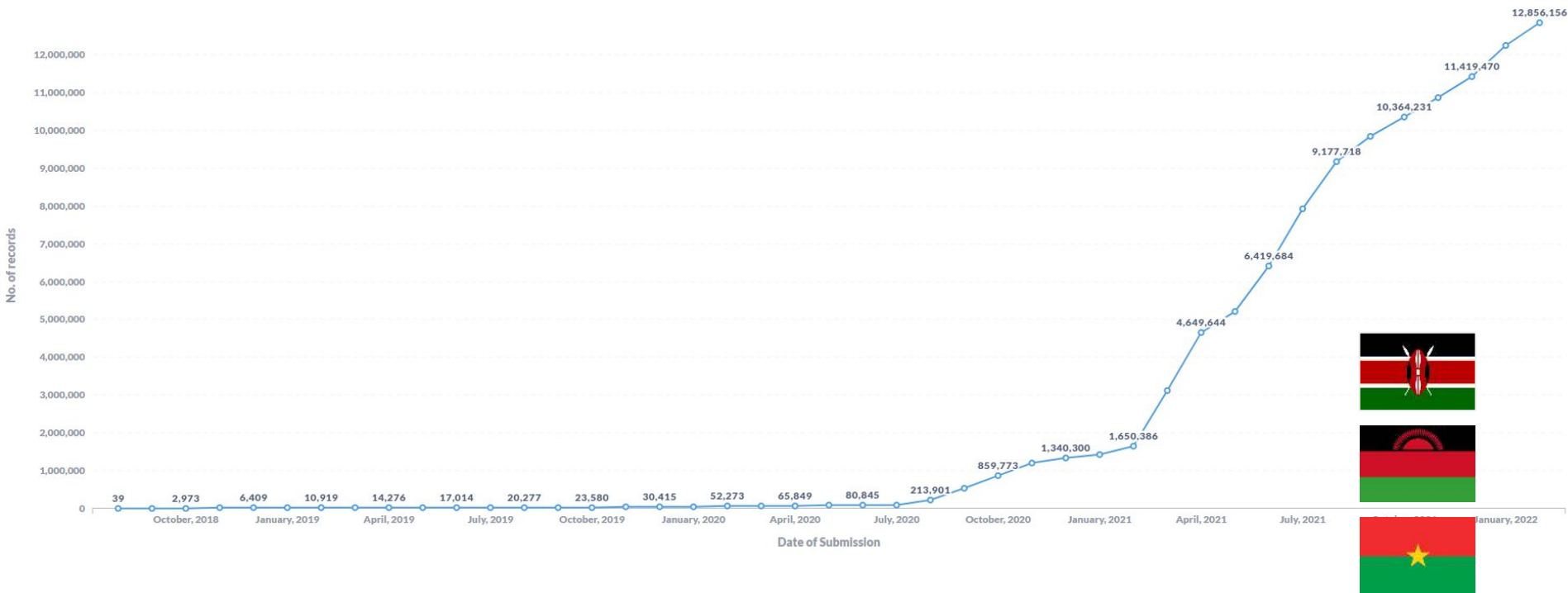
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ScanForm
qed.ai



Exponential Growth: +15M Patient Records

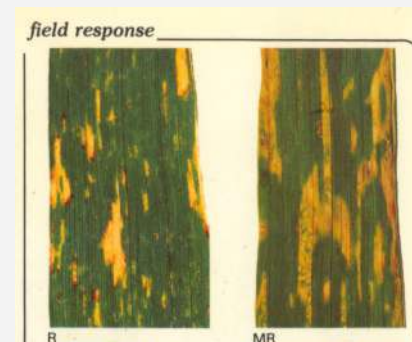


Farmer profiling, breeding, and food security



Using ScanForm, many field activities become practical and scalable:

- Last mile data collection with smallholder farmers and agrodealers
- Plant epidemiology and crop health monitoring
- Yield trials and the world's food security depends on acquiring agronomic feedback!



YIELD TRIAL NOTES

Trial metadata

Trial ID

Occurrence

Cycle

Nursery name

Cooperator ID

• Cross the ovals with an "X" like this: ☐ • Please do not bend or wrinkle the paper!

• If you have made a mistake in an oval or box, then fill it in completely, like this: ☐

KACHU/SUAL/4/ATTILA*2/PBW65/PIHA/3/ATTILA/2*PASTOR
 Selection History: CMSS10Y003745-099Y-099M-1WGY-06 Origin: MX117-18 MTES&BESTLBW

Leaf Rust modified Codd scale

% ☐ TR ☐ R ☐ MR ☐ MS ☐ S ☐ VS

Stem Rust modified Codd scale

% ☐ TR ☐ R ☐ MR ☐ MS ☐ S ☐ VS

Yellow Rust modified Codd scale

% ☐ TR ☐ R ☐ MR ☐ MS ☐ S ☐ VS

Septoria

Other 1:

Other 2:

double-digit scale

%

%

%

Height cm

Heading days from sowing

Maturity days from sowing

Grain Yield grams per plot

1000 Kernel grams

Agronomic Score 1=worst, 5=best

Disease or other notes

Thanks for listening!



<https://qed.ai> | info@qed.ai | @TweetQED