Designing Appropriate Computing Technologies for Rural Development

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Financial Services for the Poor

Microfinance: Global Movement

- Grameen Bank & Muhammad Yunus – 2006 Nobel Prize

Self-Help Groups (SHGs) - ROSCAs, ASCAs, Village Bank, etc.

- Collect savings during meetings
- Use capital for small loans
- Business, livestock, education, health care, etc.
- Repayment based on peer pressure

<u>Decentralize</u> financial service provision

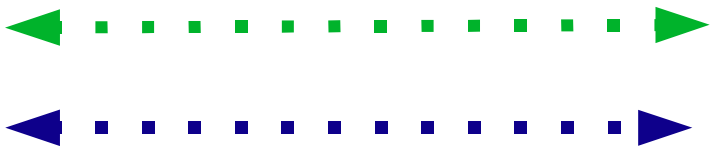
Linking Formal and Informal

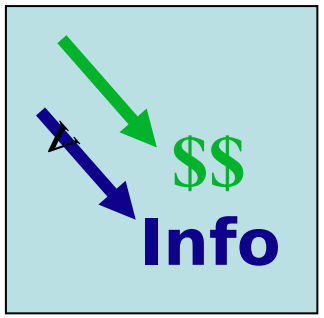
SHGs are being linked to banks

- ✔ Access more credit at better rates
- ✔ Other services (insurance, investment, savings, etc.)
- ✔ Local intermediation can reduce cost of service
- ✔ Excellent repayment performance (90-98%)

However, many obstacles **Parikh - ICTD 2006**

- ✗ Spread across remote rural areas
- ✗ Limited education, infrastructure, financial capacity
- ✗ Documentation practices are inconsistent
- ✗ Difficult to assess credit risk and make decisions





SHGs

Banks

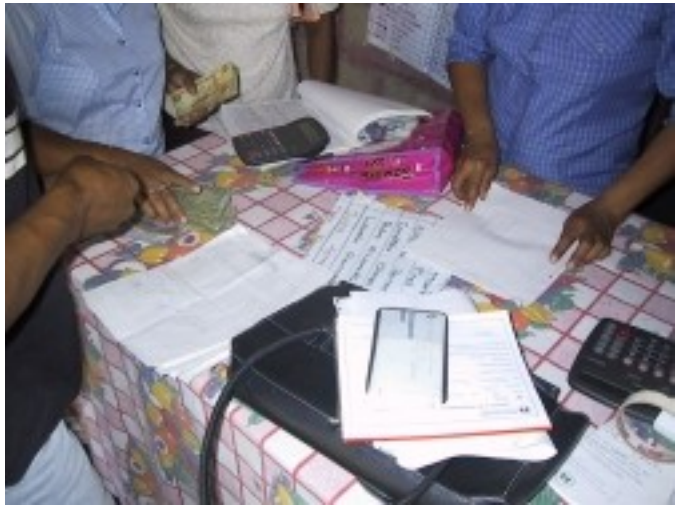
Information can be the Bridge

Information can bridge the divide

- Connect the formal and the informal
- Provide oversight and understanding for SHGs
- Provide credit ratings and risk analysis for banks
- Result: SHGs get better rates for better performance

Can we design a system for SHGs to aggregate data?

- Accessible to users
- Accurate and efficient
- Intermittent power, connectivity
- Generalizes to other applications



Overview & Methodology

Understand Context

A highly 'embedded' approach to designing, developing and evaluating technology

Build Solution

CAM: a mobile phone toolkit for distributed data collection in the rural developing world, and several applications using it

Evaluate Impact

Microfinance – actively used in India

Agriculture – pilot in Guatemala and Mexico

Public Health – tested in Tanzania

Step 1: Understand

2002-3

Design for Rural Users

Investigate interface design space for rural users
- SHG members and supporting staff
- Some may be semi-literate or illiterate
- Use SHG data collection as sample application

Only previous work was Grisedale et al., CHI 1997
- Data collection for rural health care workers in Rajasthan
- Using Apple Newton

We used laptop / PC for maximum flexibility
- Not considering real deployment issues



contextual study

Weekly by Clusters Monthly MIS for Mahakalasam payment

SNo. வரிசை எண்	Member Name உறுப்பினர் பெயர்	வரவினம் Receipts						கடன் நிலுவை	வட்டி நிலுவை	மொத்தம்	செலவினம்		
		No. ரசீது எண்	Saving Subscription சந்தா வரவு	கடன் வரவு principal loan repaid	வட்டி வரவு interest payed	நிர்வாக நிதி Maintenance fund	இதர வரவு other receipts	Loan due principal due	Interest due	Total due (loan)	வவுச்சர் எண் Voucher No.	புதிய கடன் New loan	[illegible]
	ஆரம்ப இருப்பு 'opening balance												
	கையில் ரொக்கம் cash at hand												
	வங்கி இருப்பு Bank balance												
	மகாகலச டெபாசிட் Mahakalasam Deposit												
	மகாகலச கூட்டு தொழிலுக்கு " " (enterprise)												
1													
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	மொத்தம்												

கலச ஒருங்கிணைப்பாளர் கையொப்பம் Coordinator ~~Kalsa~~ cluster incharge

எழுதுபவர் கையொப்பம் Accounts

கையிருப்பு ... who ...

prototype testing

design iteration

தர்ந்தெடுக்கப்பட்ட ள்ளார்
தேதி : 12/10/02

1	விஜயா	50	50
2	பாரதிதாசன்	50	50
3	கார்த்திக்	50	0
4	பிரியா	50	☐
5	மீனா	50	
6	லல்லி	50	
7	சித்ரா	50	
8	சத்யானந்தன	50	
9	சகுந்தலா	50	
10	வி'வகானந்தன்	50	
11	கார்த்திக்	50	

4 பிரியா

50

12.10.02	50	✓
05.10.02	50	✓
22.09.02	50	✓
15.09.02	0	✗
03.09.02	50	✓
26.08.02	50	✓

ஆரம்ப இருப்பு 12.10.02

குழுவின் மொத்த சேமிப் 1080

Group Investments

கையிருப்பு 1600

Bank balance 6850

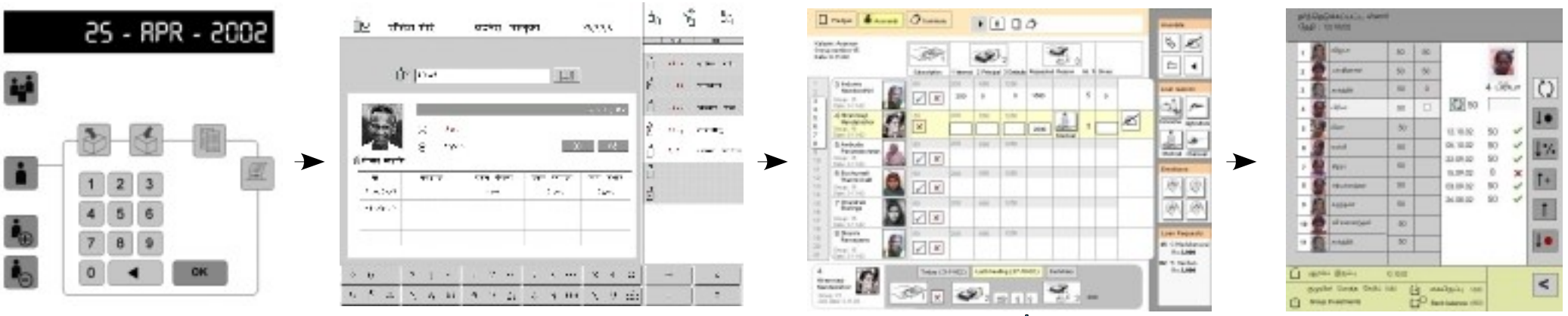
Design Guidelines for Rural Users

Parikh et al. - ACM CHI 2003, ACM CUU 2003 (Best Paper)

Two-month iterative design study conducted in a village

32 rural users - farm laborers (10 semi or illiterate)

- ✔ Paper formats are important
- ✔ Local language audio builds trust
- ✔ Numeric input/output is accessible
- ✔ Guide the user through the task
- ✔ Realistic icons are better



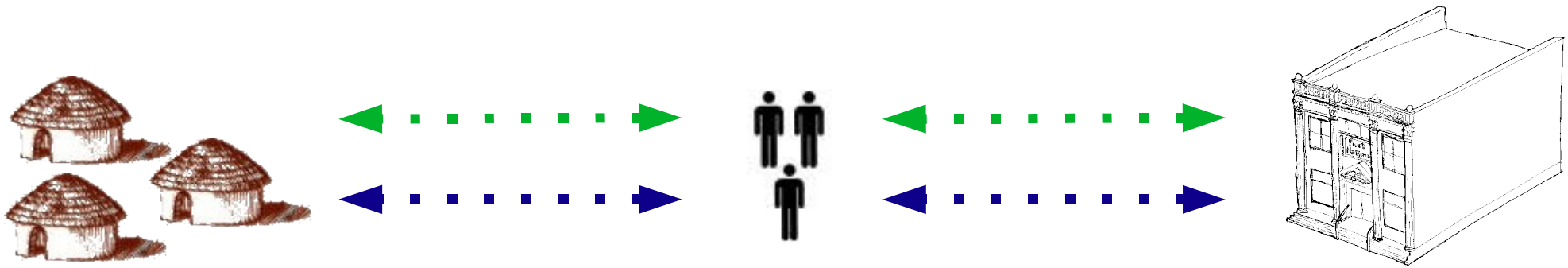
Step 2: Build

2004-5

1) Agents - Rural Service Providers

Agent Model: Provide services through local intermediaries

- Employ underemployed youth and women
- Convenient for users / clients (travel is hard!)
- Common motif for many services
  - Primary health care
  - Retail supply chains
  - Agriculture
  - Communications, etc.
- In microfinance, {bank, NGO} field staff collect info, repayments & deliver reports



2) Mobile Phones

Mobile phones are the perfect client device

- Exponential growth across developing world
- Numeric Keypad, Speakers & Microphone
- Intermittent network, Battery-operated, Low-cost
- Supports Agent-based service model

Problems and Limitations

- Small screen: adapted WIMP metaphor
- Numeric keypad: text entry is difficult
- Difficult to program applications

source: grameen-info.org

3) Paper User Interfaces

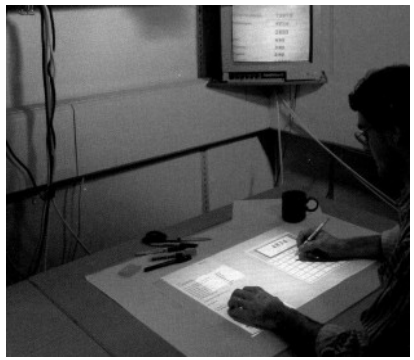
Leverage affordances of paper in digital UIs

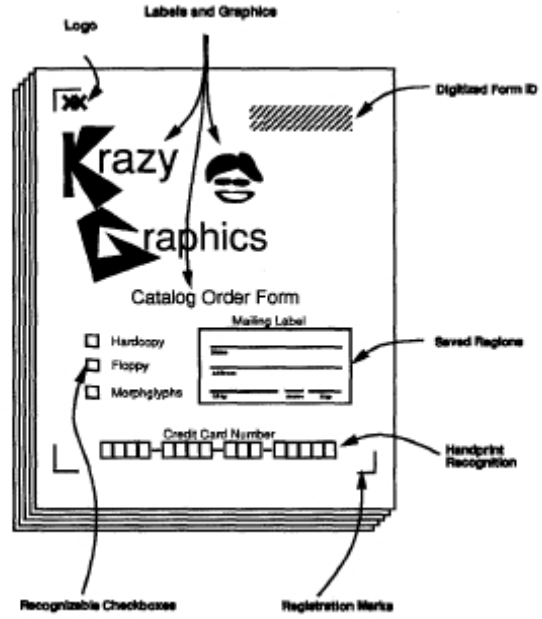
- XAX, Digital Desk, A-Book, Paper PDA, Cooltown, Books with Voices, etc.

However, thus far these approaches have had limited impact

Rural developing world could be the killer application

- Familiarity with paper formats
- Offset high technology cost by performing some operations on paper “client”



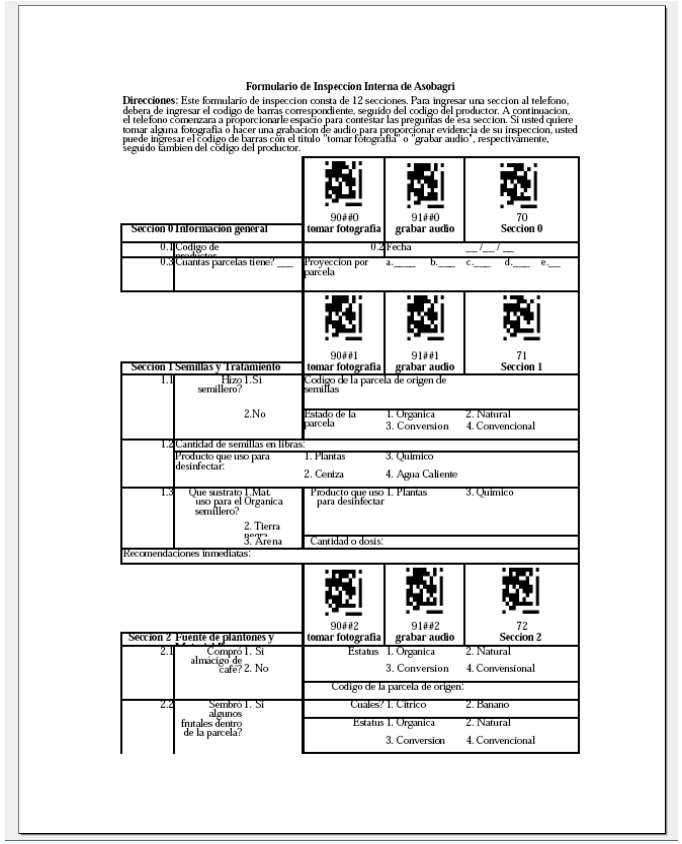


CAM: Application Toolkit for Mobile Phones

Parikh et al. - IEEE Pervasive 2005, WWW 2006

CAMForms

interactive paper forms



Formulario de Inspeccion Interna de Asobagri

Direcciones: Este formulario de inspeccion consta de 12 secciones. Para ingresar una seccion al telefono, debera de ingresar el codigo de barras correspondiente, seguido del codigo del productor. A continuacion, el telefono comenzara a proporcionarle espacio para contestar las preguntas de esa seccion. Si usted quiere tomar alguna fotografia o hacer una grabacion de audio para proporcionar evidencia de su inspeccion, usted puede ingresar el codigo de barras con el titulo "tomar fotografia" o "grabar audio", respectivamente, seguido tambien del codigo del productor.

		90##0 tomar fotografia	91##0 grabar audio	70 Seccion 0
Seccion 0 Informacion general				
0.1	Codigo de productor	0.2 Fecha __/__/__		
0.3	Cuantas parcelas tiene? __	Proyeccion por parcela	a.___ b.___ c.___ d.___ e.__	
		90##1 tomar fotografia	91##1 grabar audio	71 Seccion 1
Seccion 1 Semillas y Tratamiento				
1.1	Hizo 1. Si semillero? 2.No	Codigo de la parcela de origen de semillas		
		Estado de la parcela	1. Organica 2. Natural 3. Conversion 4. Convencional	
1.2	Cantidad de semillas en libras:			
	Producto que uso para desinfectar:	1. Plantas 2. Ceniza	3. Quimico 4. Agua Caliente	
1.3	Que sustrato 1.Mat. uso para el Organica semillero? 2. Tierra 3. Arena	Producto que uso para desinfectar	1. Plantas 3. Quimico	
		Cantidad o dosis:		
Recomendaciones inmediatas:				
		90##2 tomar fotografia	91##2 grabar audio	72 Seccion 2
Seccion 2 Fuente de plantones y				
2.1	Compro 1. Si almacigo de cafe? 2. No	Estatus	1. Organica 2. Natural 3. Conversion 4. Convencional	
		Codigo de la parcela de origen:		
2.2	Sembro 1. Si algunos frutales dentro de la parcela?	Cuales? 1. Citrico 2. Banano		
		Estatus 1. Organica 2. Natural 3. Conversion 4. Convencional		

CAMBrowser

mobile phone app
to process forms

```
<function name="a_click">
    d = input_date("Date", "date.wav");
    i = input_int("Interest", "int.wav");
    p = input_int("Principal", "pri.wav");
    if (d & p & i)
      http_put("...");
</function>
```

CAMScript

scripting language
for form interaction

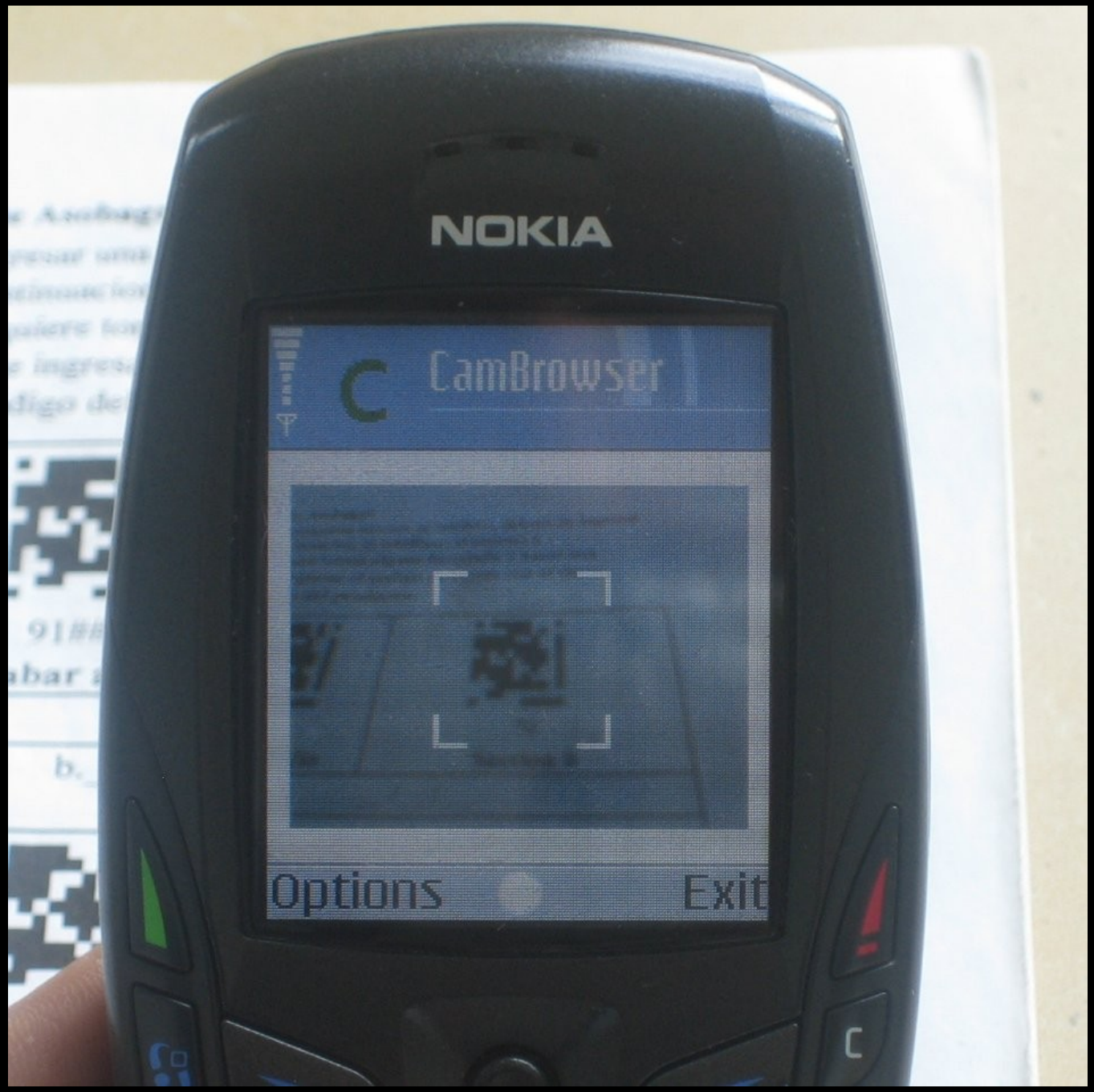
Formulario de Inspeccion Interna de Asobagri

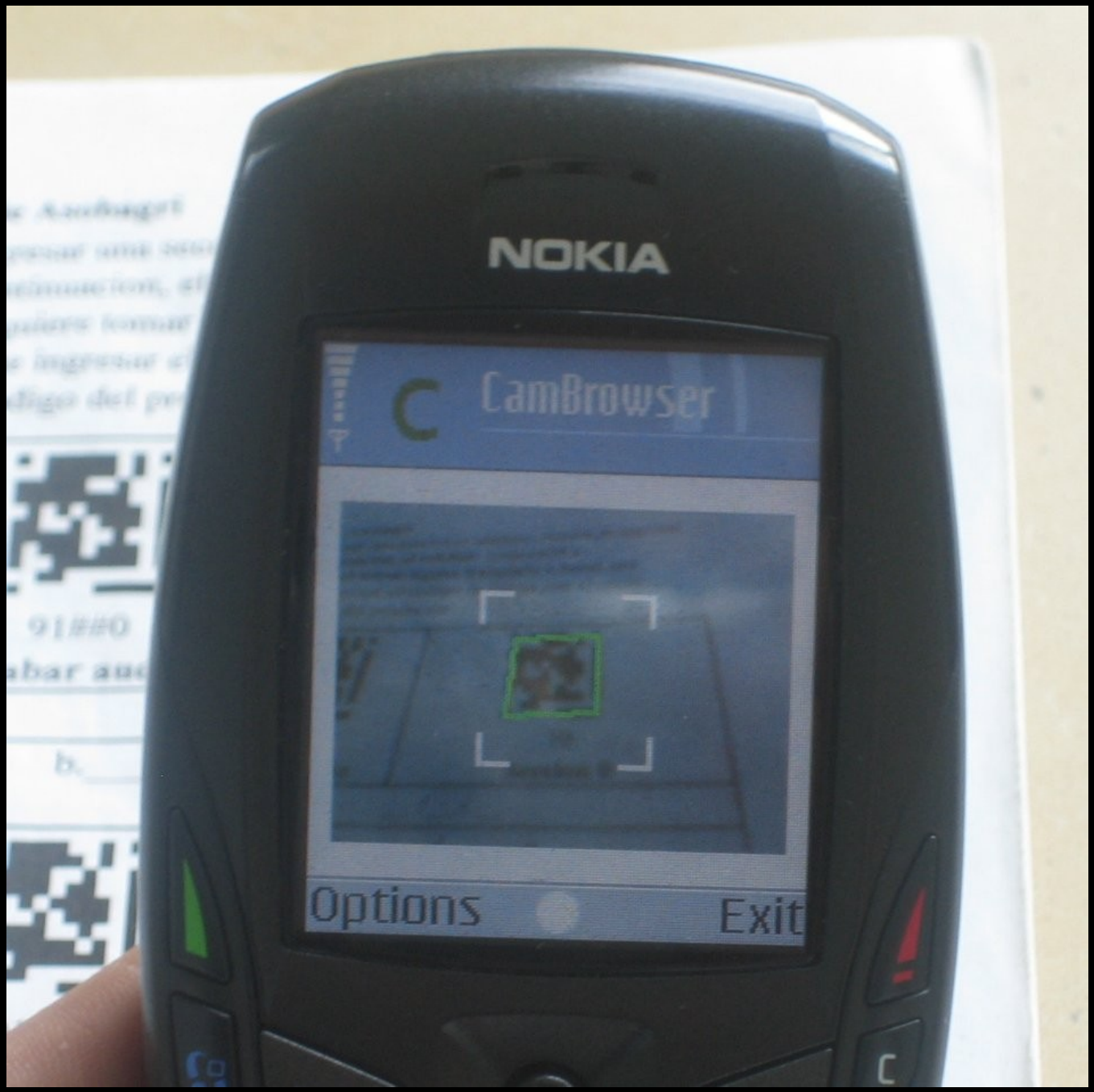
Direcciones: Este formulario de inspeccion consta de 12 secciones. Para ingresar una seccion al telefono, debera de ingresar el codigo de barras correspondiente, seguido del codigo del productor. A continuacion, el telefono comenzara a proporcionarle espacio para contestar las preguntas de esa seccion. Si usted quiere tomar alguna fotografia o hacer una grabacion de audio para proporcionar evidencia de su inspeccion, usted puede ingresar el codigo de barras con el titulo "tomar fotografia" o "grabar audio", respectivamente, seguido tambien del codigo del productor.

Seccion 0 Informacion general	90##0 **tomar fotografia**	91##0 **grabar audio**	70 **Seccion 0**
0.1 Codigo de productor	0.2 Fecha __ /__ / __		
0.3 Cuantas parcelas tiene? ___	Proyeccion por parcela a.____ b.___ c.___ d.___ e.__		

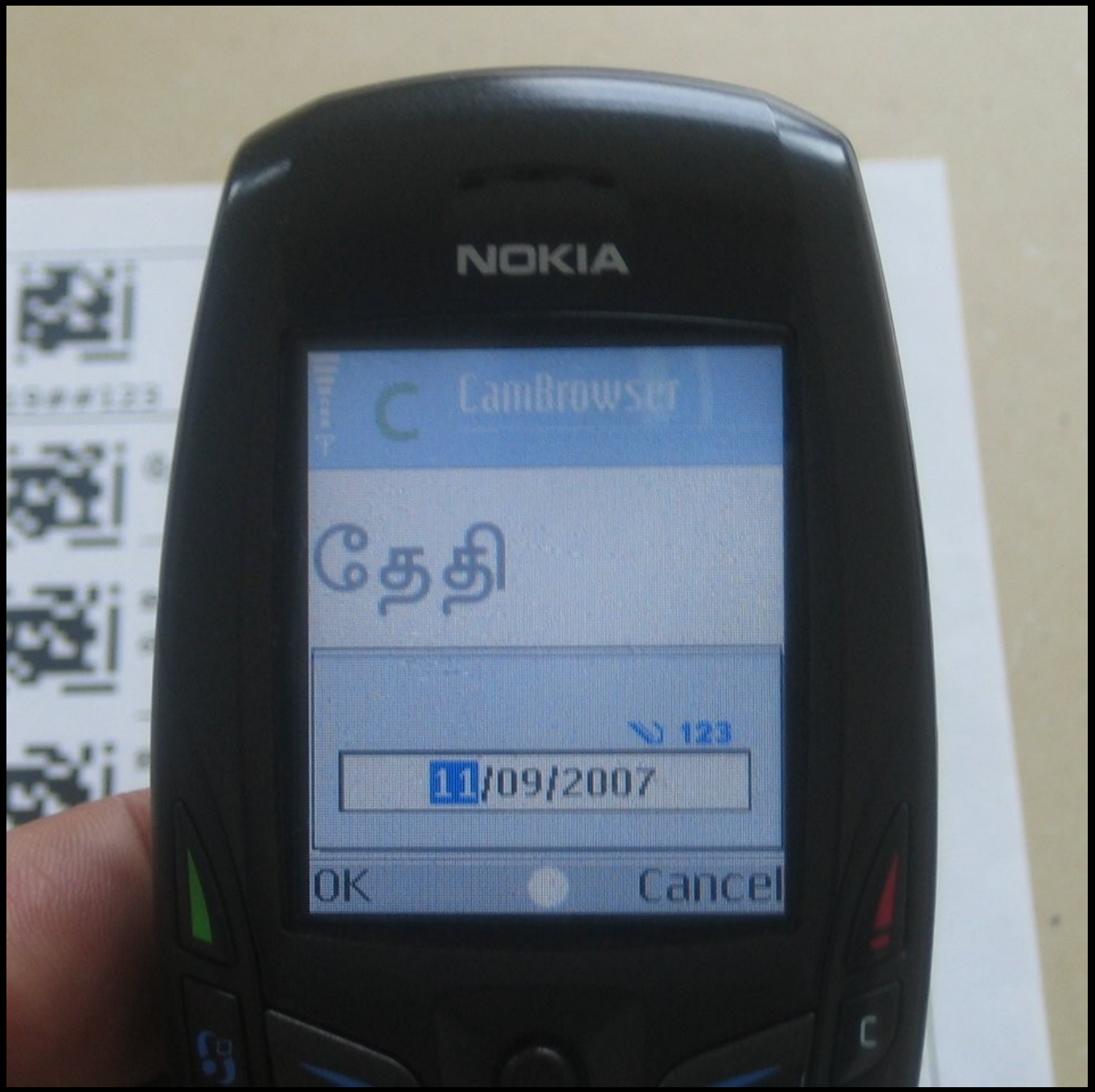
Seccion 1 Semillas y Tratamiento	90##1 **tomar fotografia**	91##1 **grabar audio**	71 **Seccion 1**
1.1 Hizo semillero? 1.Si 2.No	Codigo de la parcela de origen de semillas		
	Estado de la parcela	1. Organica 3. Conversion	2. Natural 4. Convencional
1.2 Cantidad de semillas en libras:			
Producto que uso para desinfectar:	1. Plantas 2. Ceniza	3. Quimico 4. Agua Caliente	
1.3 Que sustrato uso para el semillero? 1.Mat. Organica 2. Tierra negra 3. Arena	Producto que uso para desinfectar	1. Plantas	3. Quimico
	Cantidad o dosis:		
Recomendaciones inmediatas:			

Seccion 2 Fuente de plantones y	90##2 **tomar fotografia**	91##2 **grabar audio**	72 **Seccion 2**
2.1 Compró almácigo de café? 1. Si 2. No	Estatus	1. Organica 3. Conversion	2. Natural 4. Convensional
	Codigo de la parcela de origen:		
2.2 Sembró algunos frutales dentro de la parcela? 1. Si	Cuáles?	1. Citrico	2. Banano
	Estatus	1. Organica 3. Conversion	2. Natural 4. Convencional


NOKIA
CamBrowser
Options
Exit



Barcode Detection - Rohs 2004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123
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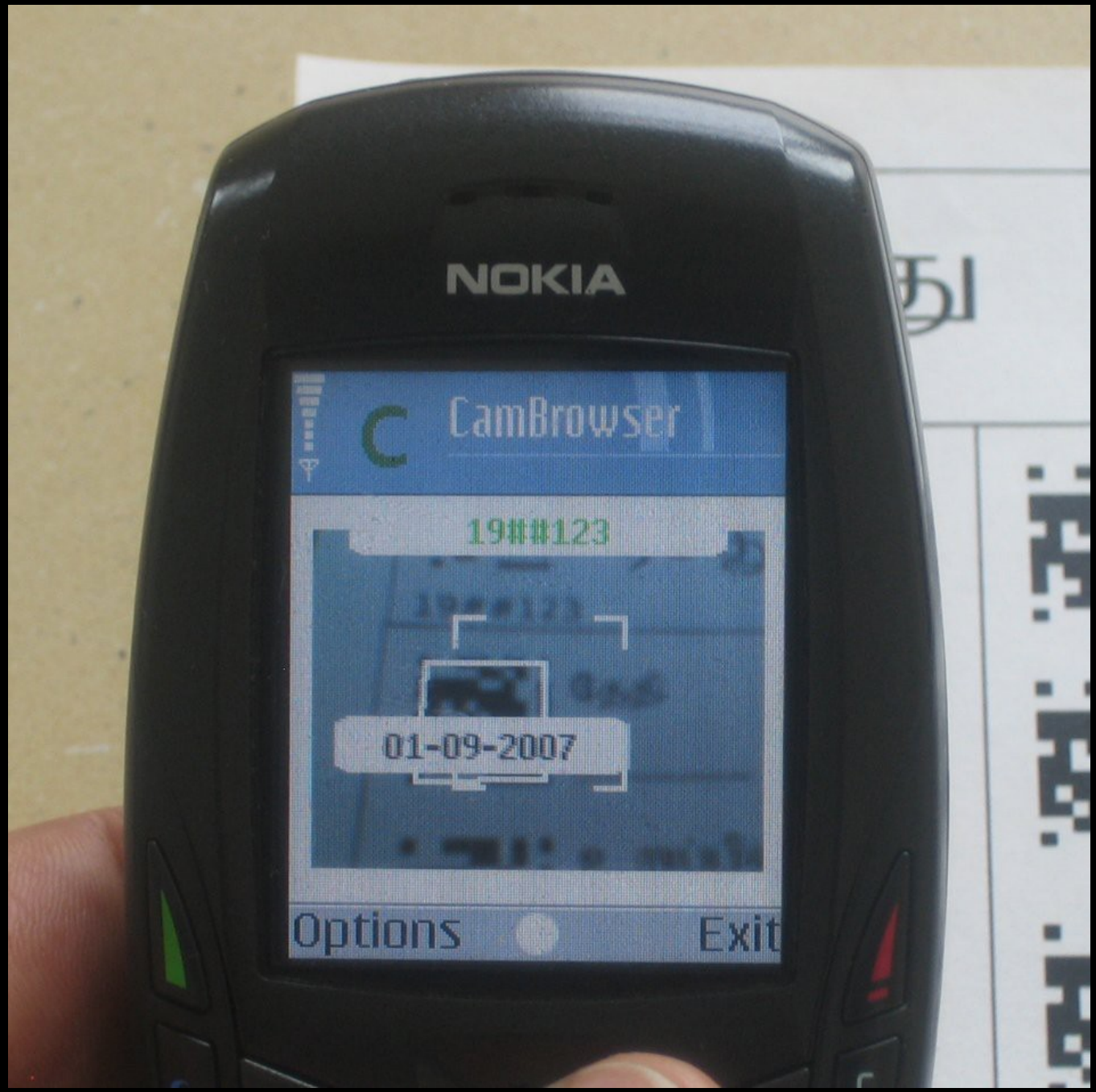
OK
Cancel


NOKIA
CamBrowser
19##123
01-09-2007
Options
Exit

CAM: Key Features

Tight linkage to paper practices

- Retain paper as the authoritative local record
- Avoid abstract, menu-driven interaction
- Not optimizing for local labor – don't need OCR!

Simple, scripted programming model

- Easy to program and use

Multimedia Input & Output

- Capture audio and images instead of text

Disconnected Operation

- Transfer data using SMS, MMS, Email (and HTTP)

```
<function name="a_click">
    date = input_date("Enter Date" "date.wav");
    amt = input_int("Enter Amount", "amount.wav");
    message_note("Say your name","sayname.wav");
    record_audio("name.wav");
    email("tap2k@yahoo.com", "a="#amt, "name.wav");
</function>
```

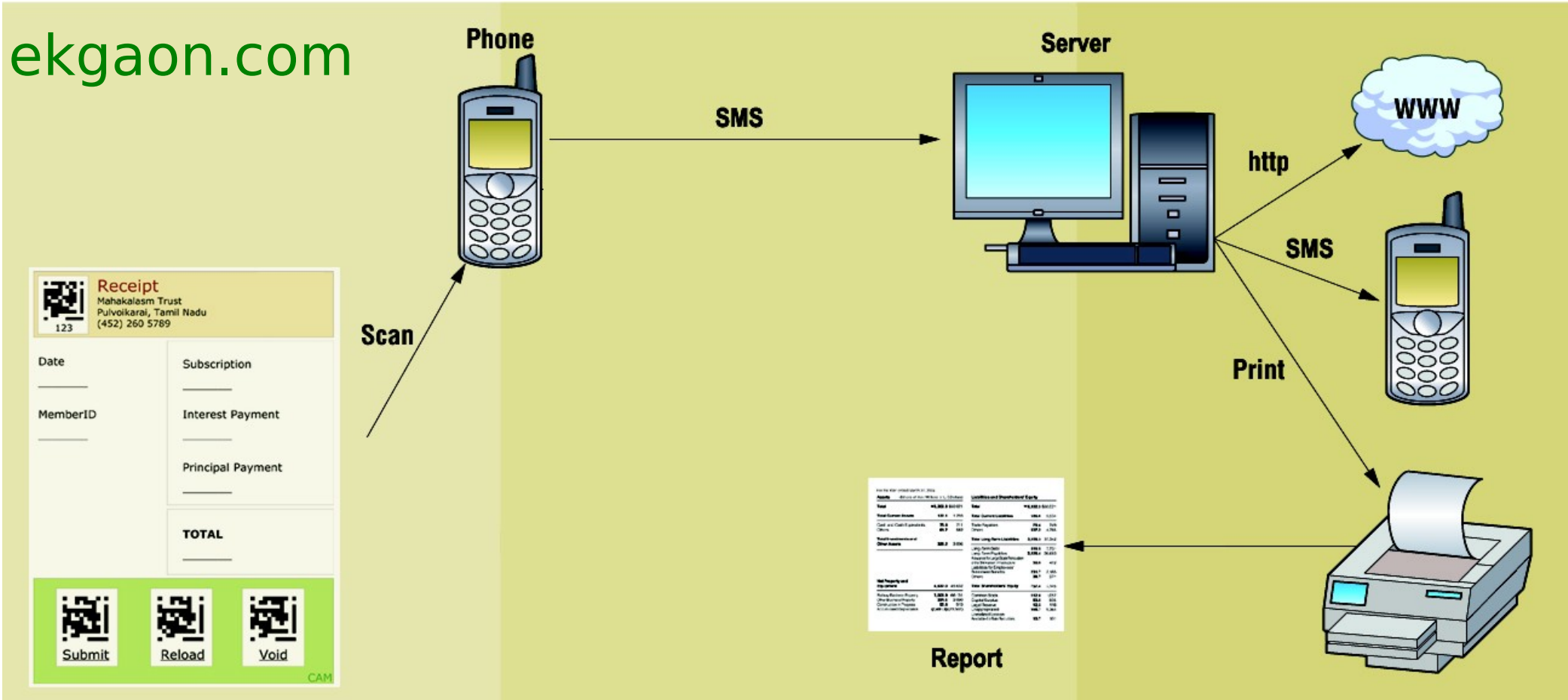
CAM: Dataflow in Microfinance

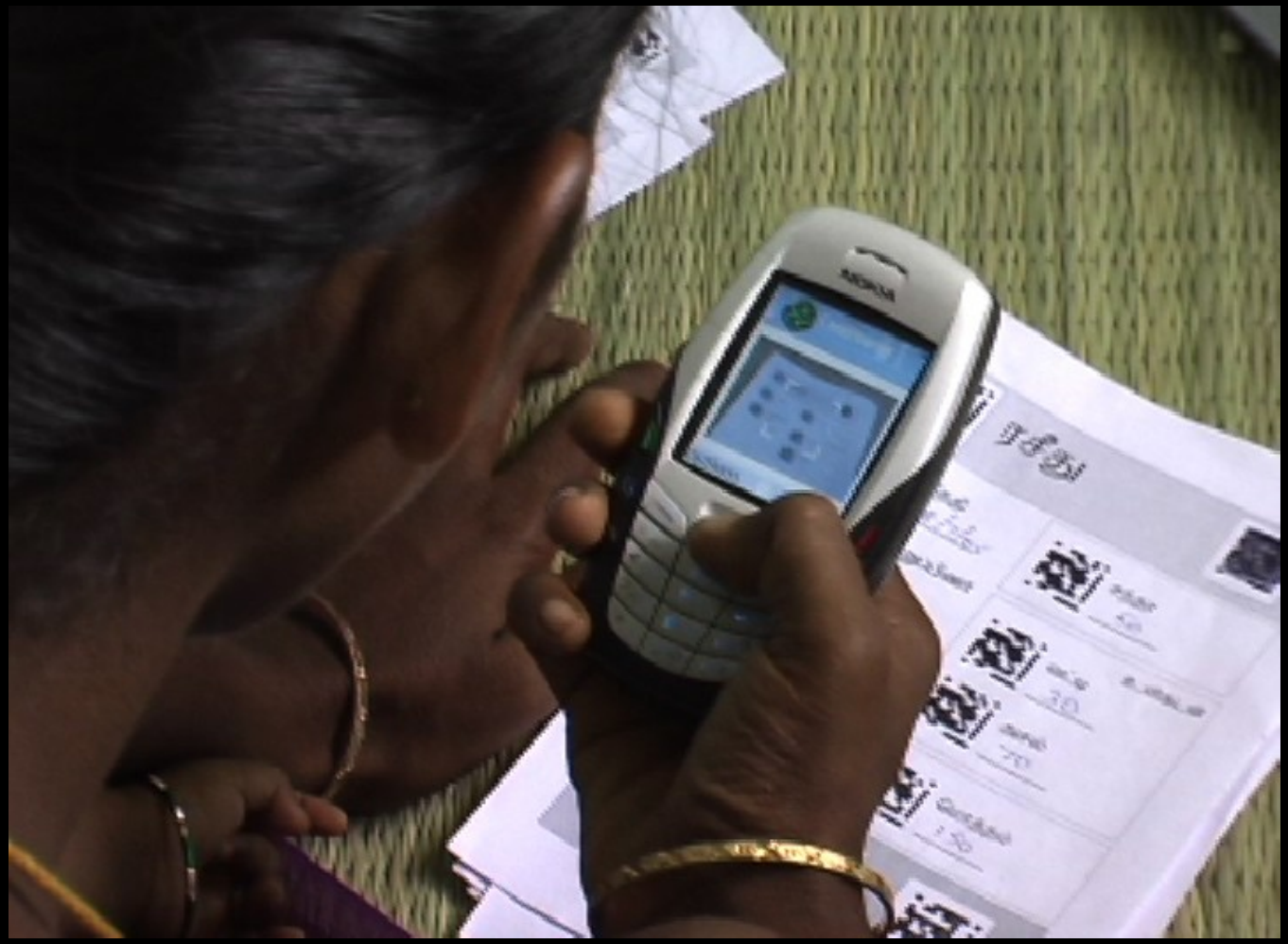
Framework for SHG data collection and reporting

Increased transparency within SHG

Improved documentation when applying for loans

Provide new services to members (e.g. flexible savings)




NOKIA

Step 3: Evaluate

2006-8

CAM: Usability Evaluation

Parikh et al. - ACM CHI 2006

Task: Record transactions during SHG meetings

- Users: 14 field agents from NGO
- 7^{th} grade to college educated
- Simulated and in situ testing

Results:

- Learnable: Learned within 1-3 sessions
- Efficient: 30 secs per form, 8-10 mins per meeting
- Accurate: Error rate < 1% (0% for in situ tests)
- Users performed significantly better with audio

CAM: Impact in Microfinance

Commercialized by ekgaon technologies pvt.ltd

2 NGOs / 17 agents / 700 SHGs / 10000 members

In active use in Tamil Nadu since October 2006

ekgaon.com

Beyond Microfinance

RECDATE	RECTIME	SPEED	ROAD_NAME	NRST_LANDM
2/1/2005	00:00:00	0		
2/1/2005	01:00:00	0	METALLED ROAD	Abdulapur
2/1/2005	02:00:00	0		

Supply Chain **Javid and Parikh - ICTD 2006**

- Monitor inventory at rural warehouses
- Plan collection & distribution
- Tested in Uttar Pradesh, India

Public Health **DeRenzi et al. - ACM CHI 2008**

- Automate clinical protocols
- Reduce training, improve adherence
- Tested in Tanzania

Agriculture **Schwartzman and Parikh - MobEA 2007**

- Monitor cultivation using pictures, audio
- Provide extension and certification
- Pilot w/ 1000 coffee farmers in Mexico

Agriculture: Digital ICS

Schwartzman et al. - MobEA Workshop at WWW 2007

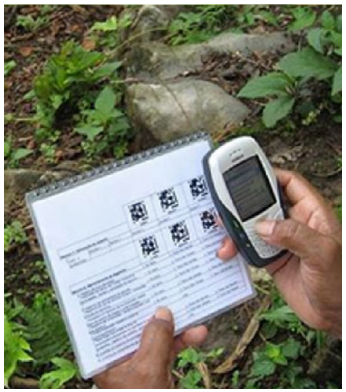
Internal control system for agri-cooperatives

Maintain quality, certifications (organic, fair trade)

Pilot w/ over 1000 small farmers in Oaxaca, Mexico

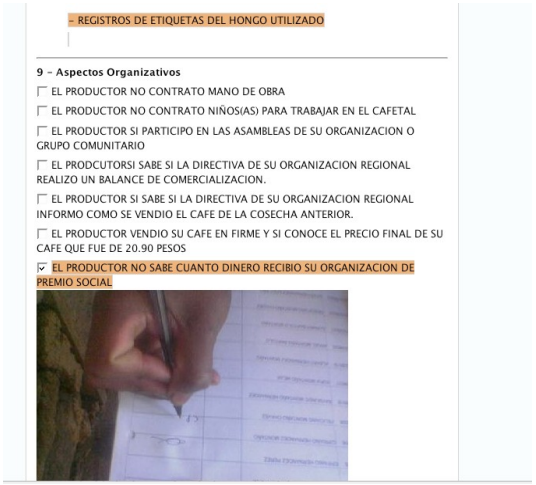
Inspection

Inspectors use **mobile phones** to monitor farms



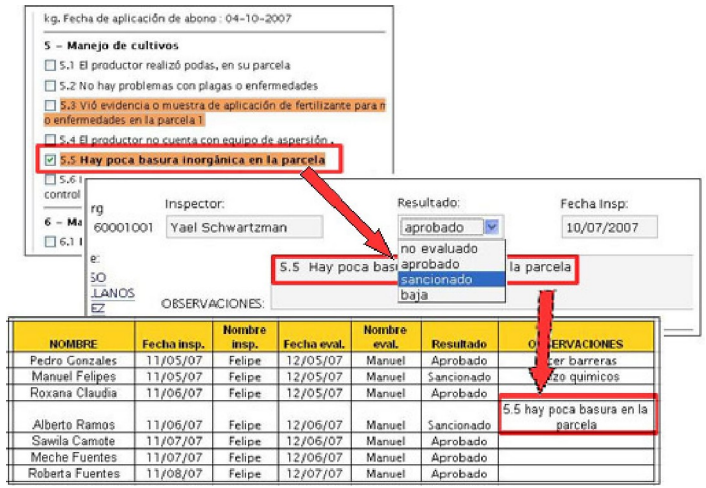
Evaluation

Evaluators use a **web application** to give feedback



Report Generation

Generate **reports** for extension and certification



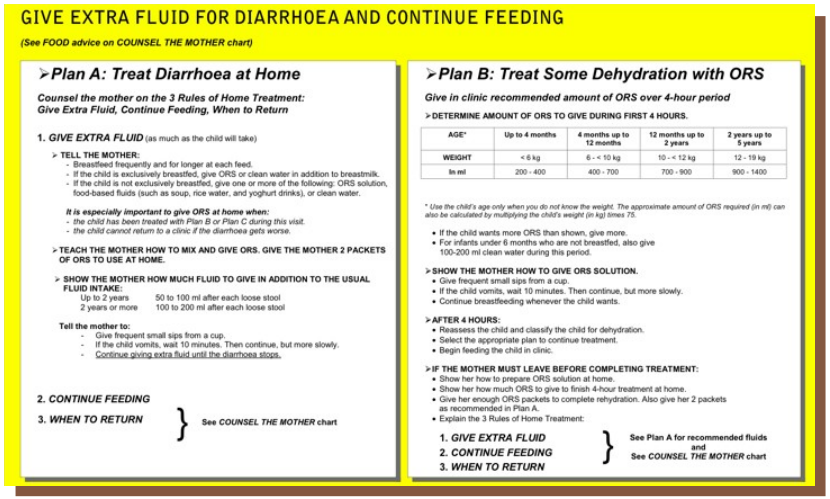
w/ Yael Schwartzman

Public Health: e-IMCI

Integrated Management of Childhood Illness (IMCI)

Use of IMCI protocol can significantly reduce child mortality (Armstrong, 2004)

Automate using mobile device to reduce training, improve adherence



GIVE EXTRA FLUID FOR DIARRHOEA AND CONTINUE FEEDING

(See FOOD advice on COUNSEL THE MOTHER chart)

➢Plan A: Treat Diarrhoea at Home

Counsel the mother on the 3 Rules of Home Treatment: Give Extra Fluid, Continue Feeding, When to Return

1. *GIVE EXTRA FLUID* (as much as the child will take)

➢ TELL THE MOTHER:
- Breastfeed frequently and for longer at each feed.
- If the child is exclusively breastfed, give ORS or clean water in addition to breastmilk.
- If the child is not exclusively breastfed, give one or more of the following: ORS solution, food-based fluids (such as soup, rice water, and yoghurt drinks), or clean water.

It is especially important to give ORS at home when:
- *the child has been treated with Plan B or Plan C during this visit.*
- *the child cannot return to a clinic if the diarrhoea gets worse.*

➢ TEACH THE MOTHER HOW TO MIX AND GIVE ORS. GIVE THE MOTHER 2 PACKETS OF ORS TO USE AT HOME.

➢ SHOW THE MOTHER HOW MUCH FLUID TO GIVE IN ADDITION TO THE USUAL FLUID INTAKE:

Up to 2 years	50 to 100 ml after each loose stool
2 years or more	100 to 200 ml after each loose stool

Tell the mother to:
- Give frequent small sips from a cup.
- If the child vomits, wait 10 minutes. Then continue, but more slowly.
- Continue giving extra fluid until the diarrhoea stops.

2. *CONTINUE FEEDING*

3. *WHEN TO RETURN* } See *COUNSEL THE MOTHER* chart

➢Plan B: Treat Some Dehydration with ORS

Give in clinic recommended amount of ORS over 4-hour period

➢ DETERMINE AMOUNT OF ORS TO GIVE DURING FIRST 4 HOURS.

AGE*	Up to 4 months	4 months up to 12 months	12 months up to 2 years	2 years up to 5 years
WEIGHT	< 6 kg	6 - < 10 kg	10 - < 12 kg	12 - 19 kg
In ml	200 - 400	400 - 700	700 - 900	900 - 1400

** Use the child's age only when you do not know the weight. The approximate amount of ORS required (in ml) can also be calculated by multiplying the child's weight (in kg) times 75.*

- If the child wants more ORS than shown, give more.
- For infants under 6 months who are not breastfed, also give 100-200 ml clean water during this period.

➢ SHOW THE MOTHER HOW TO GIVE ORS SOLUTION.
- Give frequent small sips from a cup.
- If the child vomits, wait 10 minutes. Then continue, but more slowly.
- Continue breastfeeding whenever the child wants.

➢ AFTER 4 HOURS:
- Reassess the child and classify the child for dehydration.
- Select the appropriate plan to continue treatment.
- Begin feeding the child in clinic.

➢ IF THE MOTHER MUST LEAVE BEFORE COMPLETING TREATMENT:
- Show her how to prepare ORS solution at home.
- Show her how much ORS to give to finish 4-hour treatment at home.
- Give her enough ORS packets to complete rehydration. Also give her 2 packets as recommended in Plan A.
- Explain the 3 Rules of Home Treatment:

1. *GIVE EXTRA FLUID*
2. *CONTINUE FEEDING*
3. *WHEN TO RETURN*

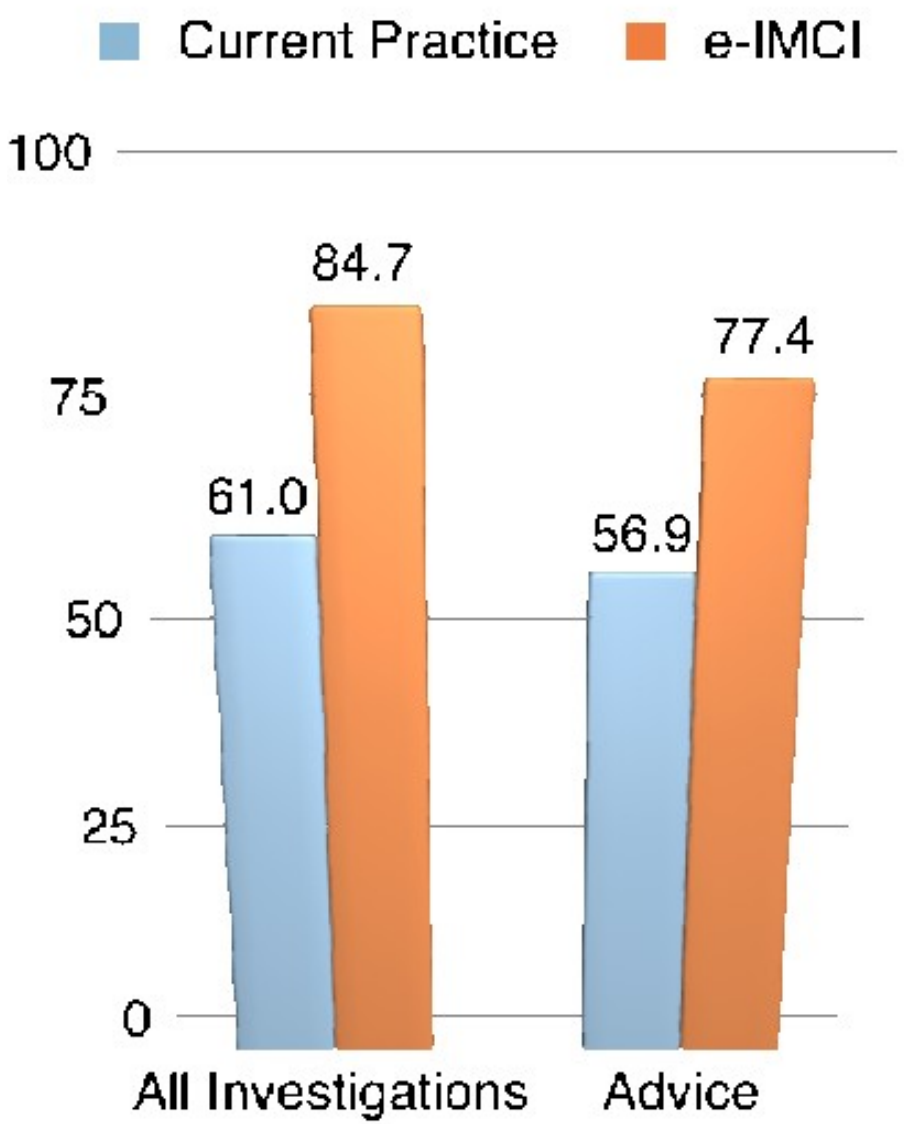
} See Plan A for recommended fluids and See *COUNSEL THE MOTHER* chart

w/ DeRenzi, Lesh, Borriello, Mitchelll

e-IMCI: Improving Adherence

DeRenzi et al. - ACM CHI 2008 (to appear)

- Tested with IHRDC in Mtwara, Tanzania
- Measured adherence to the IMCI protocol
- Observed 27 e-IMCI sessions, 24 paper-based sessions
- Use of e-IMCI can significantly improve adherence compared to current practice
- Preferred by all users



Future Work: Support Local Creators

Empower local people to build their own solutions

Physical tools for content creation and application development

Paper formats, visual and tangible programming

w/ Yaw Anokwa

Long-term Vision

Equitable Economic Development

Environmental Sustainability

Freedom & Political Stability

Information Technology

Decentralization

Final Thoughts

Design for real people & problems

Attracts diverse & energetic students

Impact sustains credibility & collaboration

Thanks for all the Fish

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