Measuring Resilience
An Approach using Data from Nepal, Bangladesh, and Uganda

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The U.S. Government’s Global Hunger & Food Security Initiative

Egypt
Secondary analysis on causes and solution to address stunting in Egypt.

Jordan
Evaluation of USAID Jordan’s Community Health and Nutrition activity and build academic capacity to support research on health and nutritional status of PW and children <2.

Sierra Leone
Sub-study to determine how EED influences the effectiveness of supplementary feeding in moderate acute malnutrition recovery.

Mali
Supported research.

Ethiopia
Supported research.

Kenya
Supported research.

Tanzania
Assess the impact of the Homegarden Agriculture and Nutrition project (HANU) in Ruliji district.

Uganda
- Uganda panel evaluation of Community Connector Program
- Birth Cohort Study: assess aflatoxin levels in women and infants
- Assessment of EED
- Capacity building—annual symposia, Banglore Boston Nutrtion Collaborative

Jordan
Evaluation of USAID Jordan’s Community Health and Nutrition activity and build academic capacity to support research on health and nutritional status of PW and children <2.

Nepal
- PoSHAN community studies: research agriculture to nutrition pathways
- PoSHAN policy research: measure the quality of nutrition governance
- Affachort study: research maternal exposure to mycotoxins, birth outcomes, and stunting in children
- AAMA: evaluation of sustained activities of an enhanced homestead food production intervention
- Child development in rural Nepal: research the relationship between diet and livestock holdings
- Livestock programs in Nepal affect on health and nutrition 4 years post-intervention
- Capacity building—annual symposia, Banglore Boston Nutrition Collaborative, and research methods workshops

Bangladesh
BAH-NR study: linking agriculture and health for dietary diversity, income, and nutrition

Mozambique
Assess aflatoxin levels in children 6-59 months of age in Nampula province.

Timor Leste
Assess extent of aflatoxin exposure in women and children.
GLOBAL AND LOCAL PARTNERS
USAID’s resilience definition

USAID defines resilience as “the ability of people, households, communities, countries and systems to mitigate, adapt to and recover from shocks and stresses in a manner that reduces chronic vulnerability and facilitates inclusive growth."

In other words, it is the ability to manage adversity and change without compromising future well-being.

USAID’s resources regarding resilience: resiliencelinks.org
Outline:

1. Setting the stage
2. One method to measure resilience
3. Applications to maternal and child nutrition
4. What does it mean for programming approaches?
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1. Setting the stage

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4. What does it mean for programming approaches?
The word “resilience” has come into widespread use

Resilience (noun):
1. the capacity to recover quickly from difficulties; toughness.
   Example: "the often remarkable resilience of so many British institutions"
2. the ability of a substance or object to spring back into shape; elasticity.
   Example: "nylon is excellent in wearability and resilience"

Opposite: rigidity, fragility, vulnerability, weakness

Frequency in English-language books, 1900-2019

Source: Definition is from Oxford Languages (https://languages.oup.com/google-dictionary-en)
word frequency is from Google Books ngram viewer (https://books.google.com/ngrams), 15 Nov. 2020.
USAID used resilience early, for crisis recovery in the 2010s

Source: Andre Mershon (2012), Resilience in USAID. https://slideplayer.com/slide/12046914
Resilience is more cost-effective than delayed responses

THE ECONOMICS OF RESILIENCE TO DROUGHT IN KENYA, ETHIOPIA, AND SOMALIA

An ounce of prevention is worth a pound of cure

Humanitarian Assistance Savings* and Avoided Losses Over 15 Year Period for Population of 15 Million as Compared to Standard Humanitarian Response

US$ Billions

<table>
<thead>
<tr>
<th>Response Type</th>
<th>US$ Billions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resilience + Safety Net + Early Response</td>
<td>$2.9 + $1.4</td>
</tr>
<tr>
<td>Safety Net + Early HA Response</td>
<td>$2.1 + $1.4</td>
</tr>
<tr>
<td>Early HA Response</td>
<td>$1.6 + $0.9</td>
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</table>

Late Humanitarian Response as defined in the report would cost $5.5 Billion

* Estimate of Humanitarian Assistance Savings is based on Total Net Cost adjusted (see report)

Resilience is now a central theme for many USAID activities

Source: https://www.usaid.gov/resilience/resources
USAID leadership on resilience is important for others as well

Source: https://www.slideshare.net/2020resilience/vaughn-institutionalizing-resilience-in-usaid-5-14

Resilience is complex, calling for a range of measurement tools
Resilience is complex, calling for a range of training materials
Resilience is complex, calling for a range of expertise

Resilience
Tools to anticipate and prepare for market shocks, health crises, political instability and weather extremes gives vulnerable people ways to manage risks and rebound more quickly.

Current and Emerging Threats to Crops: Building the Knowledge Base
Oct 21, 2020
Please join USAID Bureau for Resilience and Food Security as we consider current efforts to combat threats and share a new research opportunity to further the practice.

Source: https://www.agrilinks.org/topics/resilience
Today’s focus is measurement, building on economic methods
Our approach starts when outcomes are measured 3 times

Resilience is concerned with those who experience a decline and then recover at least some of what they lost. Are they truly resilient, or did they just experience random noise?

We compare them to others in their community who initially gained:

With random noise, gainers will lose at least some of their gains.

With resilience, those who initially lost will recover more than would be expected from randomness.

Our approach tests for resilience to any shock, as in all-cause insurance.
To measure resilience, we compare two successive changes

Our focus is on recovery after decline, which we compare to decline after improvement

Later change (for example, from 2014 to 2015)
Decline

Initial change (for example, from 2013 to 2014)
Our longitudinal (panel) surveys reveal dynamics of change

For example, over the four years of the PoSHAN survey (2013-16) in Nepal women whose dietary diversity declined recovered some of their losses while those whose diets initially improved kept most of their gains.

Women dietary diversity scores (Nepal)

Change from 2014 to 2015 (t=2 to 3) or from 2015 to 2016 (t=3 to 4)

We test for this kind of resilience in other outcomes and other populations

About half of initial declines were reversed the following year

About 1/4 th of initial gains were reversed

Change from 2013 to 2014 (t=1 to 2), or from 2014 to 2015 (t= 2 to 3)

Source: NiL PoSHAN survey data, from Zaharia et al 2020. n=1,808 women (Terai subsample only).
The method we use draws on techniques developed for financial markets, and could be applied to any outcome.

We compare recovery among those who initially decline to the degree of mean reversion experienced by those who initially gained.

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Observations in the shaded quadrant are improvements after decline. *Is that resilience?*

Estimation

\[
\Delta y_{i,t} = \alpha^- + \rho^- \Delta y_{i,t-1} + \Delta \varepsilon_{i,t}, \quad \text{if } \Delta y_{i,t-1} < 0 \quad (1)
\]

\[
\Delta y_{i,t} = \alpha^+ + \rho^+ \Delta y_{i,t-1} + \Delta \varepsilon_{i,t}, \quad \text{if } \Delta y_{i,t-1} \geq 0 \quad (2)
\]

- Bias correction

Where:

- \( y_{i,t} \) is the outcome of interest for individual \( i \) at time \( t \)
- \( t = 3, \ldots, T \) and \( i = 1, \ldots, N \).
- \( \Delta y_{i,t} = y_{i,t} - y_{i,t-1} \)

Trend and reverting tendency
\[ \Delta y_{i,t} = \alpha^- + \rho^- \Delta y_{i,t-1} + \Delta \varepsilon_{i,t}, \text{ if } \Delta y_{i,t-1} < 0 \]

\[ \Delta y_{i,t} = \alpha^+ + \rho^+ \Delta y_{i,t-1} + \Delta \varepsilon_{i,t}, \text{ if } \Delta y_{i,t-1} \geq 0 \]
\[ \Delta y_{i,t} = \alpha^- + \rho^- \Delta y_{i,t-1} + \Delta \varepsilon_{i,t}, \text{ if } \Delta y_{i,t-1} < 0 \]

\[ \Delta y_{i,t} = \alpha^+ + \rho^+ \Delta y_{i,t-1} + \Delta \varepsilon_{i,t}, \text{ if } \Delta y_{i,t-1} \geq 0 \]
Initial change (from t=1 to t=2)

\[ \Delta y_{i,t} = \alpha^- + \rho^- \Delta y_{i,t-1} + \Delta \varepsilon_{i,t}, \text{ if } \Delta y_{i,t-1} < 0 \]

\[ \Delta y_{i,t} = \alpha^+ + \rho^+ \Delta y_{i,t-1} + \Delta \varepsilon_{i,t}, \text{ if } \Delta y_{i,t-1} \geq 0 \]

Subsequent change (from t=2 to t=3)

Slope:
\[ \rho^- < 0 \]

Recovery without resilience

\[ \rho^- > \rho^+ \]

Slope:
\[ \rho^+ < 0 \]
\[
\Delta y_{i,t} = \alpha^- + \rho^- \Delta y_{i,t-1} + \Delta \varepsilon_{i,t}, \text{ if } \Delta y_{i,t-1} < 0
\]
\[
\Delta y_{i,t} = \alpha^+ + \rho^+ \Delta y_{i,t-1} + \Delta \varepsilon_{i,t}, \text{ if } \Delta y_{i,t-1} \geq 0
\]
Horizontal axis: $\rho^+$
- $\rho^+ < 0$
- $\rho^+ = 0$
- $\rho^+ > 0$

Vertical axis: $\rho^-$
- $\rho^- < 0$
- $\rho^- = 0$
- $\rho^- > 0$

Legend:
- **R** = Reversal
- **MR** = Mean reversion
- **AMR** = Asymmetric mean reversion
- **RW** = Random walk
- **MOM** = Momentum

### Improvements revert
- $\rho^- < \rho^+ < 0$ (AMR)
  - Resilience
- $\rho^- = \rho^+ < 0$ (MR)
  - Mean reversion
- $\rho^- = 0$ (RW)
  - Non-resilience
- $\rho^- > 0$ (MOM)
  - Non-resilience

### Improvements have momentum
- $\rho^- < 0$ (R)
  - Recovery without resilience
- $\rho^- = 0$ (RW)
  - Random walk
- $\rho^- = 0$ (MOM)
  - Random walk
- $\rho^- > 0$ (MOM)
  - Symmetric momentum

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Data

**Outcome:**
Dietary diversity scores (DDS) from 7-day and 24-hour diet recalls
Women’s Body Mass Index (BMI)
Children’s weight-for-height z-score (WHZ)

**Population:**
Women (13 to 47 years old) and children (2 to 5 years old)

**Geography & time:**
Nepal: Terai region, 2013-2016 (yearly)
Bangladesh: Feed the Future Zone of Influence, 2016-2017 (bi-annual)
Uganda: six districts from N and SW Uganda, 2012-2016 (biennial)

**Data sources:**
Nepal: PoSHAN survey (Klemm et al. 2018)
Bangladesh: BAHNR survey
Uganda: Uganda panel survey
## Evidence of resilience in Nepal

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Reverting tendency of declines ($\rho^-$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Women’s weekly DDS</strong></td>
<td>-0.36*** Reversal</td>
</tr>
<tr>
<td><strong>Children’s weekly DDS</strong></td>
<td>-0.54*** Reversal</td>
</tr>
<tr>
<td><strong>Women’s daily DDS</strong></td>
<td>-0.03 Random walk</td>
</tr>
<tr>
<td><strong>Children’s daily DDS</strong></td>
<td>-0.03 Random walk</td>
</tr>
<tr>
<td><strong>Women’s BMI</strong></td>
<td>0.40*** Momentum</td>
</tr>
<tr>
<td><strong>Children’s WHZ</strong></td>
<td>0.19*** Momentum</td>
</tr>
</tbody>
</table>

OLS regressions, corrected for bias. *p<0.1, ** p<0.05, ***p<0.01.

Nepal: n=3,752 (women) & 2,203 (children)

No evidence of resilience in Bangladesh and Uganda

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Reverting tendency of declines ($\rho^-$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bangladesh</strong></td>
<td></td>
</tr>
<tr>
<td>Women's daily DDS</td>
<td>0.38*** Momentum</td>
</tr>
<tr>
<td>Children's daily DDS</td>
<td>0.13** Momentum</td>
</tr>
<tr>
<td>Women’s BMI</td>
<td>0.86*** Momentum</td>
</tr>
<tr>
<td>Children’s WHZ</td>
<td>0.23*** Momentum</td>
</tr>
<tr>
<td><strong>Uganda</strong></td>
<td></td>
</tr>
<tr>
<td>Women's daily DDS</td>
<td>0.48*** Momentum</td>
</tr>
<tr>
<td>Women’s BMI</td>
<td>0.22** Momentum</td>
</tr>
</tbody>
</table>

OLS regressions, corrected for bias. *$p<0.1$, **$p<0.05$, ***$p<0.01$. Bangladesh: $n=2,753$ (women) & 1,547 (children); Uganda $n=1,617$ (women).

Source: Zaharia et al. (2020).
How does resilience vary in the population?

• In Nepal, dietary diversity resilience of women and children varies across **households** and **districts**.

• Who is most resilient?
Women and children from more market-oriented households and those with better access to credit are more resilient.

Source: Zaharia et al. (2020).
Women and children from districts with more developed infrastructure are more resilient.

Source: Zaharia et al. (2020).
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Household food insecurity across the year (Nepal 2014)

FIGURE 3  Monthly reporting of food insecurity, among farming compared with nonfarming households (n = 340 households). Vertical error lines represent 95% CIs.
Livelihood ‘resilience’ post-earthquake (Nepal 2015)

Fig 3. Post-earthquake recovery of households in earthquake-affected VDCs (N = 1056 households).
Implications?

- Program goals could include ‘net’ resilience at household or ZOI levels (to allowing for ‘churning’)?

- Co-variate shocks can weaken systems over time. Setting expectations: will your resilience programming reverse this? Over what period?

- Programs need longitudinal data to assess multiple time points (coordinate with national statistics offices)?

- We need to find ways to treat ‘past gains protected’ during shocks in ways that value this alongside ‘future gains achieved’ without shocks.
Programming implications?

- Delivery systems *made resilient:*
  - Strengthen services, inputs, assets, credit, income *flows* so that the systems *themselves are more resilient.*
  - Resilient systems support outcomes *across the food system* (wealth, jobs, purchasing power).
  - *Preparedness* can be embedded in all parts of food systems.

- Attribution is challenging. What might *not* have happened is hard to measure and value.

- We need to focus much more on supporting resilience policy and programming, via clarity on metrics and evidence.
Acknowledgements

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- POSHAN community studies – Nepal:
  - Led by Johns Hopkins University with in-country partners; National Agriculture Research Council (NARC), Nepal Technical Assistance Group (NTAG), New Era, Tribhuvan University Institute of Medicine (TUTH IOM), Tufts University.

- BAHNR study – Bangladesh:
  - Tufts University, HKI Bangladesh, Horticulture Innovation Lab, WorldFish, AquaFish Innovation Lab, Dhaka University, Strengthening Partnerships, Results, and Innovations in Nutrition Globally (SPRING).

- Uganda panel survey – Uganda:
  - Makerere University School of Public Health, Uganda; the Uganda Science and Technology Council, Kampala, Uganda.
Q&A
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