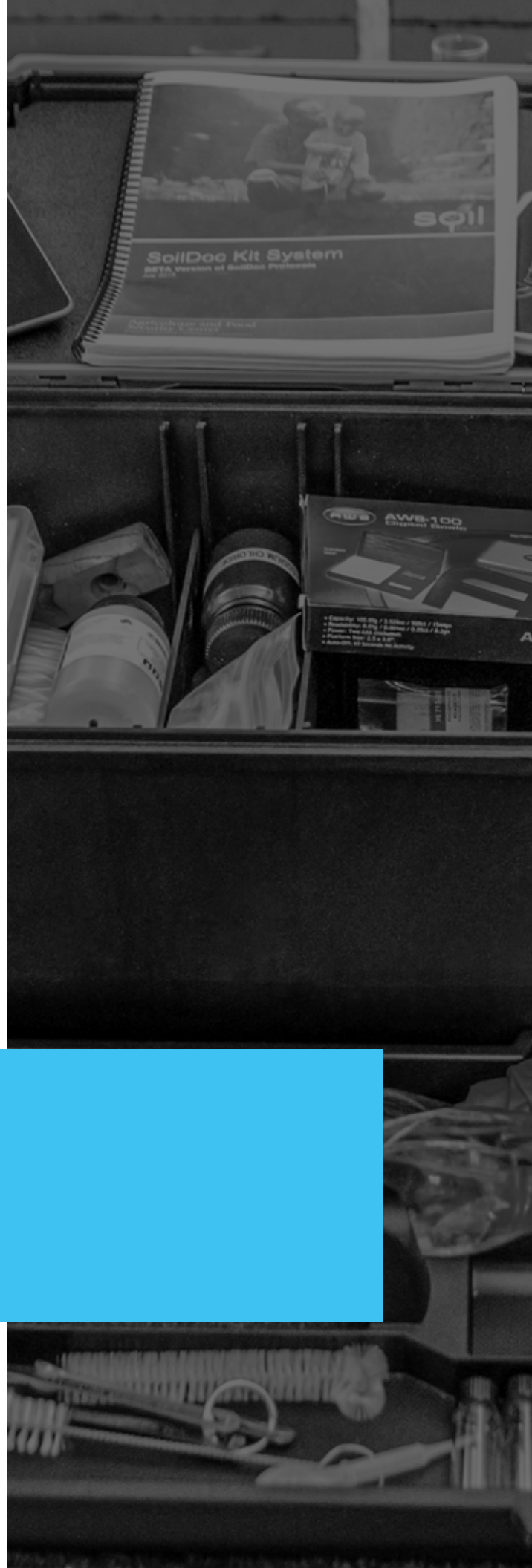




Developing Agriculture from the Ground Up

IFDC EVALUATION OF PORTABLE SOIL TESTING KITS

LESSONS LEARNED





BACKGROUND

PROBLEM

Poor soil fertility leads to low food production, particularly in sub-Saharan Africa and South Asia.

To increase productivity, farmers must apply plant nutrients (via fertilizers) that their soils lack. However, most smallholder farmers cannot access soil testing laboratories to determine their soil's fertility and the nutrients needed to increase crop growth. As a result, most farmers apply fertilizer based on blanket recommendations that do not meet the soil's actual requirements.



SOLUTION

Portable soil testing kits are an alternative to standard laboratory analysis for selected nutrients. Ideal portable testing kits are inexpensive and require minimal training.



ACTION

IFDC conducted an extensive literature study on commercially available soil testing kits and then evaluated selected kits. The kits were selected based on their widespread use and extensive promotion in developing countries. The goal was to identify kits that are accurate, affordable, portable, and user friendly. The evaluation was funded by the United States Agency for International Development (USAID).



OBJECTIVES

1. To assess the selected kits' accuracy in determining soil pH, nitrogen (N), phosphorus (P), and potassium (K) concentration, compared with standard laboratory analysis.
2. To determine the kits' ability to accurately predict plant nutrient availability in soil by comparing results with nutrient uptake and biomass production.
3. To evaluate the kits' effectiveness in providing fertilizer recommendations to smallholder farmers.





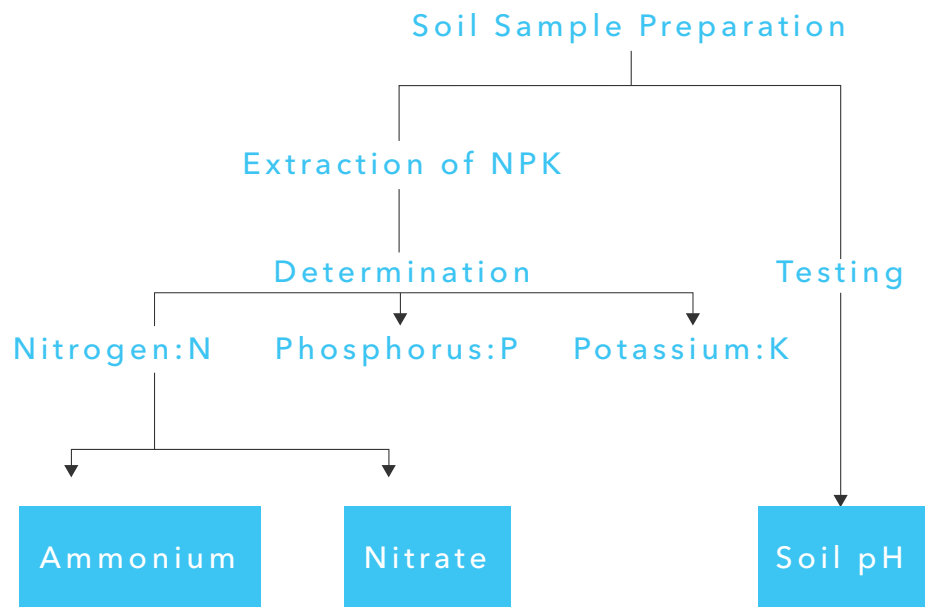
EVALUATION PROCESS

IFDC RESEARCHERS EVALUATED KASETSART, HACH, AND SOILDOC TEST KITS FOR THEIR PERFORMANCE, AFFORDABILITY, AND EASE OF USE.

These test kits are being used in several countries, such as Rwanda, Ghana, Nigeria, Liberia, Afghanistan, and Thailand.






Eight benchmark soils were used to evaluate the kits. In addition, 40 soils archived by the North American Proficiency Testing Program were evaluated. All soils varied in texture, pH, and organic matter content.

OVERVIEW OF SOIL ANALYSIS






SOIL TEST KIT ATTRIBUTES



	KASETSART	SOILDOC	HACH SW-1
 CAPABILITIES	<ul style="list-style-type: none"> Analyzes pH, ammonia-N, nitrate-N, P, and K Colorimetric-based 	<ul style="list-style-type: none"> Analyzes nitrate-N, calcium (Ca), magnesium (Mg), P, K, acidity, sulfate, electrical conductivity, and active carbon Colorimetric and digital platforms 	<ul style="list-style-type: none"> Analyzes nitrate-N and ammonium-N, P, K, Ca, Mg, sodium (Na), acidity, salinity, gypsum and lime requirement, sulfate, and electrical conductivity. Colorimetric-based
 RETAIL PRICE	\$150	\$4,000	\$1,300
 POSITIVE ATTRIBUTES	<ul style="list-style-type: none"> Easy to use and quick analysis 	<ul style="list-style-type: none"> Modern kit with large database for recommendations 	<ul style="list-style-type: none"> Easy to use
 CONSTRAINTS	<ul style="list-style-type: none"> Color scheme slightly difficult to see Small qualitative range 	<ul style="list-style-type: none"> Expensive for smallholder farmers Requires extensive laboratory skills 	<ul style="list-style-type: none"> Expensive for smallholder farmers
 METHOD OF RECOMMENDATIONS PROVISION	<ul style="list-style-type: none"> Kasetsart University developed an app that uses crop modeling (DSSAT) to provide recommendations for smallholder farmers 	<ul style="list-style-type: none"> Specific soil nutrient recommendations are made in real time through a tablet 	<ul style="list-style-type: none"> The kit comes with a booklet of recommendations based on calibrations for yield in specific crops

MAJOR FINDINGS

IFDC conducted soil test kit analyses following the procedures outlined in each kit's operating manual. Soil variables evaluated were pH, nitrate N, available P, and exchangeable K. Kit results were compared to standard laboratory analysis and a greenhouse growth study.

TEST	KASETSART	SOILDOC	HACH SW-1
pH	<ul style="list-style-type: none"> • Good correlation with standard lab analysis • Distinguished between acidic, neutral, and alkaline soils 		
	<ul style="list-style-type: none"> • Accurately detected low, medium, or high N concentration in near-neutral pH soils only • Actual N concentration values were inconsistent with lab analysis 	<ul style="list-style-type: none"> • Accurately detected low, medium, or high N concentration in near-neutral pH soils and some soils outside 6-7.5 pH range; in acidic soils, results were inconsistent with lab analysis • Actual N concentration values were higher than lab analysis 	<ul style="list-style-type: none"> • Accurately detected low, medium, or high N concentration in near-neutral pH soils and some soils outside 6-7.5 pH range; in acidic soils, results were inconsistent with lab analysis • Actual N concentration values were lower than lab analysis
	<ul style="list-style-type: none"> • Detected P values consistent with lab analysis only in soils with inherently high P concentration • In acidic soils, P values were much higher than lab analysis. 	<ul style="list-style-type: none"> • Detected P values consistent with lab analysis in acidic to near-neutral soils only 	<ul style="list-style-type: none"> • Detected P values consistent with lab analysis in acidic to near-neutral soils only
	<ul style="list-style-type: none"> • K values were inconsistent with lab analysis 	<ul style="list-style-type: none"> • Detected K values consistent with lab analysis in acidic to near-neutral soils only 	<ul style="list-style-type: none"> • K values were inconsistent with lab analysis

Note: The test kits indicated qualitative values (low, medium, or high - usually represented by a color or color range) and quantitative values (actual concentration).



GREENHOUSE EXPERIMENT

Results of the portable soil test kits were validated with plant nutrient uptake in a greenhouse experiment using maize as the test plant. N and P soil concentration values obtained with test kits did not correlate with plant uptake of N and P. However, the K soil test result obtained with SoilDoc correlated weakly with K uptake.

LESSONS LEARNED AND RECOMMENDATIONS

+ POSITIVES

- Costs less than standard lab analysis
- Obtains reliable results in near-neutral pH soils
- Some determine N and P concentration accurately compared to wet chemistry
- Some indicate accurate qualitative values (high v. low)
- Useful for gauging if nutrient content (N and P) is adequate or limited
- Useful for making fertilizer recommendations when well-calibrated with field data

- NEGATIVES

- Only reliably indicates soil pH and lime requirements
- Accuracy for N and P concentration in soils with pH below 5.5 and above 7.5 depends on choice of the kit (reagents used)
- Most are ineffective in determining K concentration
- Not useful for making fertilizer recommendations without calibrations

Soil test kits tend to produce variable results in soils with different organic matter content and pH levels. When analyzing these soils, the organic matter content and pH must be taken into consideration and, if possible, procedural calibration should be conducted before analysis to eliminate the confounding pH and organic matter effects.

Given the large number of portable soil testing kits in the market with varying capabilities advertised, IFDC recommends that more kits be evaluated to build a database of validated results.

ABOUT —
IFDC

The International Fertilizer Development Center (IFDC) is a non-profit organization focused on strengthening food security and generating economic growth for smallholder farmers through fertilizer technology, good agricultural practices, and market development.

The IFDC analysis of portable soil test kits was funded through a cooperative agreement with the United States Agency for International Development (USAID).

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