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On-farm experimentation

to identify fertilizer management practices and products for cocoa in Indonesia

The Cocoa Care and IPNI approach

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Cocoa farmer Salama Kani in Soppeng District on Indonesia's Sulawesi Island laughed and explained that despite the efforts he put into his farm, he was doing so many things wrong including randomly cutting off branches. With the Cocoa Care IPNI program, he has attended the Mars Cocoa Academy and implemented Good Agricultural Practices (GAP) and fertilizer treatment.

Today, he is seeing the productivity on his cocoa farm increase. Farmers in Soppeng have had limited training and knowledge in cultivating cocoa. Their source of knowledge traditionally comes from within the farming community with government support irregular at best. The farmers have few reliable external sources for technical solutions or new knowledge. Cocoa yield in Sulawesi averages around 500 or less kg/ha/year. This compares poorly with possible commercial yields of 3 tonnes/ha/year, suggesting there is significant potential to improve harvests for Sulawesi's cocoa farmers. Fertilizers will have to play a role in this improvement process and Cocoa Care and IPNI engage with farmers to find out just how fertilizers contribute to yield and what the best product formulations should look like. This article tells the story how this is being done in the cocoa fields of Sulawesi.

Why on-farm experimentation?

Experimentation is defined as a process of discovery, hypothesis testing or demonstration. Conventional experiments are designed and managed by scientists who place value on the information about the quantifiable effects of factors and discount information about the farming environment in which they occur. Under this scenario, the effects of factors are known, the interaction with the farmed landscape less so. This generates generalizable 'scientific' statements that are true within the bounds of experimentation, but moves knowledge away from the competence that farmers need to have to manage particular conditions that exist on-farm. Where the problem can be defined by a limited set of factors this approach can be astonishingly effective. However, the approach leaves substantial variability unexplained.

Many farmers find insights from formal experiments difficult to apply and most smallholders in developing countries do not have access to such information in the first place. On the other hand, farmers themselves also experiment. They do so following two principles. The first is heuristic: each time a farmer prepares a field, plants and manages a crop, he observes and experiments under a unique set of conditions. Thus, farmers are continuously, although often unconsciously, experimenting as they manage their crops to cope with the changing circumstances.

The second principle is cognitive: farmers frequently try to answer specific questions by consciously experimenting on their farms. In the former case they let their competence guide them in managing their crops according to the particular social, economic and environmental conditions that occur. In the latter case they wish to increase their competence by obtaining knowledge, based on deliberate experimentation that can help them manage variation in the future.

Cocoa Care's Kate and Noel Janetski with cocoa carers and farmers

> *Farmers find insights from formal experiments difficult to apply*

Determining factors

The purpose of both cases of experimentation is to reduce decision uncertainty, but scientists and farmers give different priority to different types of uncertainty. For example, farmers must consider all factors relevant to a decision, even if they apply outside the farm gate. The decision of a farmer to apply a certain amount of fertilizer depends not only on the yield it is expected to support but also on factors such as price and availability of fertilizer products. By contrast, scientists refer less to external values in order to focus on clarity of result. Scientists often pre-define part of a system as an object of experimentation, for example by locating fertilizer experimental plots in sites that avoid impact from complicated terrain (such as nutrient loss by erosion and leaching). Farmers, conversely, are obliged to manage their farmland as they find it and modify their practices to fit the variation, rather than ignore it. Also, agricultural scientists seek clear, unambiguous statements about the effects of fertilizers far beyond the precision needed by farmers. All scientists learn statistical analysis to identify improvements that are frequently quite small and often irrelevant for farmers given the magnitude of uncertainties from other sources. Furthermore, farmers handle temporal variability through experience of prior events and conservatism when uncertain. For example, farmers who live in areas with a strong influence of El Niño will have a fertilizer strategy that ensures that they will not face a total disaster even if there is a Niño year, whilst at the same time providing them with an acceptable result in a non El Niño year. In many circumstances, this may mean that farmers are suspicious of using fertilizers at all. Observations that farmers make in the process of experimentation are most valid for the farm on which they are produced, but at the same time can be used by others under similar conditions and may prompt more conventional experiments within the farm setting to bridge the boundaries between formal science and farming practice.

How to operationalize on-farm experimentation in cocoa landscapes

Global production of cocoa has surged strongly over the past 20 years to nearly 4.6 million tonnes, most from West Africa (FAO 2016). Between 2020 and 2025, consumers' demand for cocoa will increase by one million tonnes (ICCO 2015), mainly driven by the growing consumption in the Asia-Pacific region. Until recently, growth of production has been almost entirely through expansion of area. Indonesia is no exception. At the same time, yield in Indonesia has since 2010 dipped below 0.5 t/ha, undermining cocoa farm profitability and presenting substantial risks to the survival of the industry. The opportunity for Indonesia is to benefit from growth in global demand by pushing yield consistently beyond one or even 1.5 t/ha. The importance of adequate crop nutrition to achieve such high cocoa yields has long been known. At the same time, the use of fertilizer in Southeast Asian smallholder cocoa systems is not common. Clearly, the linear transfer of technology model has failed in this aspect and needs to be amalgamated with a process of developing farmer competence through on-farm experimentation. Most scientists continue to regard on-farm experimentation as a marginal activity and few farmers receive the support that is critical for its success. Therefore, Cocoa Care and IPNI organized on farm experimentation that promotes sharing of experiences between farmers, farmer groups and between farmers and researchers and fertilizer supply chain partners.

Cocoa Care, a scalable sustainability programme, aims at raising the living standards and productivity of cocoa farmers in Sulawesi, Indonesia. Together with various private and institutional sponsors, it is helping poor farming families to achieve a more sustainable future by providing farm management training with necessary tools, short-term farm input support (typically two years) and community support. Cocoa Care is managed by PT Community Solutions International (CSI), a Foreign Investment Company based in Indonesia with the aim of developing long term, sustainable business solutions that provide new or alternate livelihood opportunities for marginal communities. It is not affiliated with any private company or government programs. Cocoa Care does not have any contractual relationship with farmers. Farmers participating in programmes do so on a voluntary basis. The vision is developed on cultivating trust and understanding with cocoa farmers. By leveraging and mobilizing existing resources, training centres and infrastructure, Cocoa Care supplemented farmers' traditional source of knowledge by providing a coordinated link to established networks of private, corporate, governmental and non-governmental institutions. Cocoa Care engages with farmers through Cocoa Carers, highly trained independent farmers who help other farmers manage their cocoa farms while acting as a community bridge to Cocoa Care. Through this sustainable farmers' support network, Cocoa Care has the reach to work with farmers based on mutual trust and respect. This is achieved with the presence of Cocoa Carers and Monitors living and working within the farming community. Cocoa Carers supervise productivity and impact monitoring by using hand held tablets with mobile data connectivity, cloud based storage, database, front-end dashboard for data entry and reporting. Photos of field and plant conditions are taken and uploaded into designated folders of farmers for progress record.

Applied nutrients increased the size of beans when compared with those from fields that received only good agricultural practices but no fertilizers

> *"Most scientists continue to regard on-farm experimentation as a marginal activity*

How to develop cocoa fertilizer recommendations using our on-farm approach

Key components in our approach are capacity building of farmers and two types of on-farm experiments. The first set of trials demonstrates the effectiveness of crop nutrition to increase yields, while the second set of trials is designed to measure the contribution of individual nutrients to that yield increase. The first objective is reached with simple split farm designs where parts of the farm receive fertilizers and others only good agricultural practices excluding external nutrients. Understanding of the role of individual nutrients is developed from omission plots embedded into farmers' fields, where one nutrient at a time is taken out of the fertilizer program. Nutrients are applied using the 4R Nutrient Stewardship, where the right source of fertilizer is used, at the right rate, the right time and in the right place. Nutrients are applied twice a year with the onset of the rainy season. We bury the nutrients in four, 20 cm deep holes with 10 cm diameter, equally spaced around the tree, along the edge of the canopy to match root growth. In on farm experimentation it is critical to have a large number of farms participating and we work with more than 50 farms in the Soppeng area.

Our initial fertilizer recommendations were developed based on the replacement of nutrients that are exported with a target yield of 2 t/ha. Replacements were calculated based on information on crop removal of nutrients that we discovered in a few published articles and based on our own experience. During the first years of the program, we updated this information constantly with data that are produced by frequent sampling of soil and plant tissue (leafs, beans and husks). Interpreting such data together with information of harvest records and an understanding of the social fabric and financial resources of farmers, enables us to identify the most appropriate formulations and

The Cocoa Care IPNI approach starts at the nursery. Cocoa carer Darwis prepares for grafting

The Cocoa Care IPNI initiative helps to set up farmer owned nurseries

IPNI's Oberthur auditing the implementation of GAP, here pruning - a precondition for sustainable return on investment in fertilizer

> *Under the programme, farmers can see improvements generally within three months*

associated management practices for fertilizers that help farmers achieve yields that provide sustainable income. IPNI is currently engaging its member companies and their business partners to get these formulations into commercial production.

Sharing knowledge

The Cocoa Care IPNI approach is based on local farmers' experimentation as part of their normal farm management process. Farmers will interpret the results of such experimentation with their level of knowledge - competence. Results are often shared between farmers and a successful farming practice spreads organically. Cocoa Carers become the educational bridge that connects with other farmers on the ground.

Most farmers participating in the project had previously been disheartened due to falling harvests and several were on the verge of giving up cocoa farming despite the rising world demand. Under the programme, farmers can see improvements generally within three months of implementing GAP. With the external nutrients some farms had reached pre-program annual harvest within the first six months of the project and several farmers harvested more than 1.5 t/ha already in the first year. Cocoa Care and IPNI are now in the development of farmer owned agri-input kiosks that enable the link between responsible fertilizer use and fertilizer supply chains. ■

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