**Supplemental material 1: Collaborative, needs-based development of the initial draft SAK picture lessons**

The initial 100 picture lessons were drafted by the principal investigator/agricultural scientist (Manish Raizada) based on results of comprehensive smallholder household surveys (including female drudgery, production agriculture, income, nutrition, health, infrastructure, extension services, post harvest, value addition, cooking, etc.). The surveys were conducted in India (3 states), Nepal, Sri Lanka and Haiti (the 30 page “SAK Survey”, SAK Nepal 2018) over 2 years (2012-2014). The survey tool was drafted by the scientist, and then extensively edited collaboratively with staff of NGOs from the 3 South Asian countries. Commonalities amongst the needs defined by smallholders, as well as their innovations, were noted. The lessons were then actualized in collaboration with a graphic designer (L. Jay Smith) as part of the SAK Nepal project. The scientist, who was also the principal investigator of the SAK Nepal project, had several years of experience teaching and working with small-scale farming in South Asia and Sub-Saharan Africa. The scientist visited the SAK Nepal project villages several times and earlier related project sites in India and Sri Lanka starting in 2011. The graphic designer also visited villages in Nepal and had discussions with male and female farmers for one week to understand the local context, customs and culture. During the development phase, the scientist received additional feedback from the local Nepali NGO staff as to the types of lessons needed.

From the beginning, target audience of the picture lessons were women and children, and hence, to be relatable, assumed that the lead characters should primarily be women, and also children, where appropriate. Furthermore, the scientist envisioned creating a compendium or book of lessons for the five different regions of the world, having large populations of smallholder farmers (i.e. South Asia, East Asia, Sub Saharan Africa, North Africa/Middle East, and Latin America). The scientist understood that only subsets of lessons would be relevant to each region. It was envisioned that if graphic software was used, the lessons could be culturally adapted to the different regions as appropriate (e.g. by changing skin pigment, dress, crops, landscape, house design, etc.). The lessons were placed online and available for open access without copyright. An additional companion, open-access, online encyclopedia is currently in development that sources and critically analyzes the literature, with each entry corresponding to one picture lesson, to provide the underlying rationale and critical analysis of each lesson. This encyclopedia is not evaluated here.

For each lesson, the recommended practice was, in many cases, a local or a traditional practice in another region of the world but not widespread globally. In most cases, the recommended practice was based on the peer-reviewed literature, convincing grey literature from different projects, or the first-hand experience of the scientist.

In terms of process, each picture lesson required up to four weeks to develop, and five lessons were developed in parallel. In Week 1, the scientist and graphic designer met for three hours online (by Skype with screen share, because they worked in separate cities in Canada) to discuss each picture lesson concept including what types of images to include. The scientist shared relevant images where possible (e.g. his own collection or Google images of seeds, male and female farmers, crops, livestock, agronomic practices, etc.) to help explain concepts and ensure that the lessons were realistic, accurate, relevant and culturally appropriate. Based on each discussion, the designer developed a black and white pencil sketch and shared it with the scientist during their Week 2 online meeting. At this second meeting, the scientist made clarifications and suggestions. During Week 3, during their online meeting, the graphic artist shared the first colour/professional draft of each lesson using Adobe Creative Cloud software, and the scientist suggested near-final improvements. Finally, during Week 4, minor edits were suggested, or final edits were approved. In total, the scientist and graphic designer met three hours every week for approximately one year to create the 141 draft lessons, with the graphic artist working full time. At a later time, the scientist added plain language, brief text captions in English using Adobe software, which was subsequently translated into Nepali by a former LI-BIRD staff member who had then become a doctoral student in Canada.

During the initial development of the picture lessons, the scientist and the graphic designer worked collaboratively since each had a different lens, with the graphic designer more versed in effective communication. Early on, it was decided that stock graphic images would be created by the graphic artist (e.g. a Nepali adult female farmer, a specific crop or livestock species, house) that could be used in multiple lessons for consistency in communication and for efficiency, but also so that they could be easily swapped to adapt the lessons to different parts of the world (e.g. farmer dress and skin pigment). To relate the images to a South Asian farmer context, the first decision was the physical appearance of the male and female characters in each lesson, including skin pigment, dress, culturally appropriate clothing coverage, and hairstyle. The major challenge was how to communicate that a recommended practice/product was improved compared to an existing practice/product. This value proposition was communicated using two strategies. First, the existing practice/product was consistently shown in a box on the left of each lesson, with the recommended practice on the right. Second, consistent types of comparative value images/symbols were used such as: one versus two or three piles of grain (to show improvements in yield); a yellow/diseased field versus a green field; different stacks of hard currency (the designs reflected Nepali currency); a sad human face versus a happy face; a sick child versus a healthy child; arrows pointing to parts of the body experiencing pain; water droplets versus an “X” on top of the droplets to communicate drought, etc. A short duration of time was explained using day-to-night transitions, while an extended duration of time was explained using phases of the moon. The importance of such visualizations, including mistakes made in assuming they are universally understood, are discussed in the relevant communication and development literature. For this reason, local input, review and revision of the visual communication is an essential stage of developing picture lessons.

**Participatory editing of SAK picture lessons with women farmers as editors**

The 141 SAK picture lessons were formally tested with female farmer groups belonging to Majhthana VDC in Nepal in January 2016 using participatory methods (as stated in the second phase of data collection of research in Section 3.2). The picture lessons were tested in discussions with five focus groups, each consisting of 10-12 women farmers from different ethnic and age backgrounds (age range 20-55 years). In total, 56 women farmer editors were involved from different wards (the smallest unit of a VDC) within Majhthana VDC. A projector and laptop were used to project the picture lessons on the wall of a community building, where the discussions occurred. The women were asked to verbally interpret the lesson one by one; they then talked amongst themselves and then they explained their interpretation of each lesson step by step to the interviewer (a female). If their interpretation was different than the lesson intent, the interviewer clarified the lesson objective(s) and asked for detailed feedback as to understand the causes of the discrepancies (e.g., specific images) and how they could be improved. The interviewer wrote the edits directly on each image. The entire process was assisted by a trusted and known female extension agent of the local NGO, LI-BIRD, who resided in the VDC. The written edits were converted into English text in Adobe and then sent to the scientist who consulted with the interviewer for clarification, prior to sharing/explaining the edits to the graphic designer. The edited lessons were shared by Skype with the interviewer in Nepal, who sometimes requested further edits to the images. In some cases, the edited images were again shown to the original women farmers for their approval. In total there were approximately 500 edits requested by the women farmer editors, which were completed over a period of six months using the same online process described above.