






UNMET NEEDS REPORT

KOPERNIK

EXECUTIVE SUMMARY

OVER THE PAST SIX YEARS OF WORKING IN LAST MILE COMMUNITIES ACROSS INDONESIA, WE HAVE WITNESSED WIDESPREAD CHALLENGES FACED BY SMALLHOLDER FARMERS.

We believe that understanding a problem is a necessary first step required in order to solve it, thus we have written this report to articulate some of the issues and unmet needs of the farmers and to highlight opportunities to address them.

The World Bank estimates that **at least 18 million smallholder farmers in Indonesia live below the global poverty line**. They make up one third of the entire Indonesian agricultural sector labor force. These smallholder farmers are trapped in a poverty cycle of low farm productivity and low income, compounded by unpredictable weather patterns. To break this cycle and alleviate poverty on a truly meaningful scale, we need innovation.

This report aims to make the challenges faced by Indonesian smallholder farmers as clear and accessible as possible. In doing so, Kopernik is inviting the private sector, government, development organizations, and civil society to collaborate and contribute to addressing the unmet needs of this sector.

Given the variety and complexity of agricultural processes, this report focuses on the post-harvest value chain of 10 agricultural commodities in Indonesia. Within the post-harvest process, we examine in detail the crucial step of drying as this was the most commonly cited challenge experienced by farmers during our research.

This is both a social opportunity to tackle poverty challenges, as well as an economic opportunity to reduce post-harvest agricultural losses, improve efficiency and explore untapped markets. This untapped **market of inefficient drying is estimated at $3 billion for the ten commodities studied**, as detailed in the chart below:

Figure 1: **Estimated market size of inefficient drying (US dollars)**

1	Rice	1,740,173,000
2	Maize	613,742,000
3	Copra	289,695,000
4	Coffee	109,454,000
5	Cacao	77,661,000
6	Cloves	56,016,000
7	Pepper	50,059,000
8	Vanilla	3,516,000
9	Garlic	2,994,000
10	Sorghum	176,000
TOTAL		**2,943,486,000**

BY FOCUSING ON DRYING IN THIS REPORT, WE ARE NOT SUGGESTING THAT IMPROVED DRYING TECHNIQUES WOULD SOLVE ALL OF THE PROBLEMS FACED BY SMALLHOLDER FARMERS; RATHER, WE SEE DRYING AS AN ENTRYPOINT INTO IMPROVING FARMERS' LIVELIHOODS AND ONE THAT IS LIKELY TO RESULT IN HIGHER QUALITY AND VALUE OF COMMODITIES SOLD BY INDONESIA'S SMALLHOLDER FARMERS.

While exploring post-harvest drying, our research revealed a huge gap between demand and supply. **On the demand side, most smallholder farmers resort to the ubiquitous practice of sun drying.** This means the farmers and their precious crops are at the mercy of the weather, and the practice also leads to damage of about 5% of commodity volume due to inefficient drying.

On the supply side, we discovered 12 types of agricultural dryers designed for one or many of the 10 commodities under review. While most of them cater to major grains like rice and maize, too few cater to and have been tested for the other less common commodities. The prices of all the dryers are prohibitively high for rural, low-income farmers, even if they were to buy and use the dryers collectively.

If cross-sectoral collaboration could bridge this demand and supply gap in crop drying, a range of economic and productivity gains would be realized for smallholder farmers. **Effective drying could result in a positive spiral of higher income, greater control over time and activities, and overall reduced vulnerability to external factors.**

We are fully aware, and know from our own product development experience that this is easier said than done; **product development requires multiple iterations of prototyping and testing, supplemented by a deep understanding of user needs and perspectives.**

Furthermore, once a product is developed, getting it to the places where it's most needed is just as difficult, as we have learned through our Wonder Women technology distribution initiative.

BEHAVIOR CHANGE ALSO PLAYS A BIG PART IN GETTING PEOPLE TO ADOPT NEW TOOLS AND PRACTICES - IT'S NOT JUST ABOUT BUILDING EFFECTIVE HARDWARE.

We at Kopernik, however, are excited about the potential of fulfilling these unmet needs and feel compelled to take on this challenge with like-minded partners. We hope you will join us on this journey and become one of them after reading this report.

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ABOUT KOPERNIK

KOPERNIK CATALYZES SIMPLE SOLUTIONS TO REDUCE POVERTY IN LAST MILE COMMUNITIES. WE HAVE DELIVERED 87,000 INNOVATIVE TECHNOLOGIES, SUCH AS SOLAR LIGHTS, WATER FILTERS, AND CLEAN COOKSTOVES, TO 380,000 PEOPLE AS OF NOVEMBER 2016.

An award-winning social enterprise founded in 2010, Kopernik is not only a social incubator and a field implementer, but also a research firm and an advocacy agency focused on innovation.

Kopernik works in the entire innovation funnel continuum from early stage testing to scale out. It is **one of the few social enterprises in Indonesia operating at scale with networks covering the archipelago from Aceh to Papua**.

Kopernik's local networks and implementation capacity attract some of the most innovative organizations in the world to collaborate with us to develop products and services for base-of-the-pyramid segments. Kopernik's edge lies in combining bold ideas, demonstration, evidence, and influence.

If you are interested in learning more about how our consulting and advisory services can assist you, please contact us at consulting@kopernik.info

THIS RESEARCH WAS FUNDED, DESIGNED, AND IMPLEMENTED BY KOPERNIK. OUR PRIMARY INTENTION FOR THE RESEARCH IS DRIVEN BY OUR URGE TO MAKE A DIFFERENCE IN THE LIVES OF LOW INCOME FARMERS.

Through our work over the past six years, Kopernik has engaged with dozens of last mile communities across Indonesia. **We have built a distribution network of women entrepreneurs which delivers simple, life-changing technologies like solar lights, water filters, and clean cookstoves to remote communities.** At the same time, we have partnered with more than 20 corporate and public sector clients on market research and product and service development initiatives.

All our work in technological innovation for last mile communities has been nudging us to do more in the agricultural sector - the largest economic activity in rural Indonesia. **Thus, in early 2016 we decided to invest resources to systematically map agricultural value chains and share the key findings with the general public.** This report is a result of this effort - a call for innovation and collaboration in Indonesian agriculture.

Authors of this report:
This report was researched and written by Kopernik's Last Mile Consulting team, namely Trista Bintoro, Tomo Hamakawa, Radityo Hutomo, Nadya Pryana, and Prita Raditiarini. Many other members of Kopernik contributed to the research and resulting report, including Anna Baranova, Toshi Nakamura, and Ewa Wojkowska.

THE RESEARCH BEHIND THIS REPORT WAS CONDUCTED BY THE KOPERNIK LAST MILE CONSULTING TEAM BETWEEN FEBRUARY AND AUGUST 2016.

The team traveled to Sumatra, Java, Sulawesi, Bali, and Nusa Tenggara and visited a total of 60 farmers and small business owners inquiring about their day-to-day activities and challenges.

The fieldwork covered value chains of 33 items, including non-agricultural commodities like bricks and salt. We then applied a few filters to this long list, including completeness of information and coherence among selected items, to arrive at the final list.

Combined with countless hours of desk-based research on their science and economics, the 10 commodities found in this report were selected. These commodities are grouped under three categories: **grains (rice, maize, sorghum); plantation crops (cacao, coffee, coconut); and spices (pepper, cloves, vanilla, garlic)**.

Halfway through the research, we discovered that there is a reason why similar value chain mapping exercises have not been conducted in Indonesia. Finding scientific and market data on less common commodities like vanilla and sorghum is not easy. This poses challenges in trying to present data in the same, standard structure for all the selected commodities. The proportion of damage and loss due to inefficient drying methods in particular was a difficult figure to find. Given these challenges, we have made a conscious effort to be clear about the data sources and are open to updating the figures if more accurate ones become available.

We are aware of other limitations of this research. External validity - or the ability to extrapolate findings to other geographical or socioeconomic contexts - may be low for some of the **more subjective information such as challenges faced by farmers in each step of the pre- and post-harvest processes.** Market price is, by definition, a fluid figure but the report presents it as a fixed number for the sake of analysis.

CALLING FOR CROSS-SECTORAL COLLABORATION, THIS REPORT IS INTENDED FOR A WIDE AUDIENCE INTERESTED AND ENGAGED IN THE INDONESIAN AGRICULTURAL SECTOR.

PRIVATE SECTOR

We invite **companies, research institutes, and individuals engaged in engineering, design, and manufacturing to seize these social and financial opportunities, and cater to these unmet needs.**

Kopernik is keen to facilitate and conduct testing of prototypes to accelerate the R&D process.

GOVERNMENT

We invite the **Indonesian government at all levels - national, province, regency, district, and village - to leverage agricultural technologies as an effective way to lift farmers out of poverty.**

Kopernik is keen to select a few testing sites as innovation labs to test what works and doesn't work.

DEVELOPMENT ORGANIZATIONS

We invite **multilateral and bilateral agencies, as well as private foundations, to support interventions tackling challenges faced by smallholder farmers.**

Beyond drying and post-harvest processes, Kopernik is keen to conduct research into other specific agricultural and non-agricultural unmet needs.

CIVIL SOCIETY

We invite **international and local nonprofits and social enterprises to share their experiences and know-how in developing effective solutions to inefficient practices in marginalized communities.**

Kopernik is keen to learn from other actors in this field and forge partnerships to better serve the unmet needs of agricultural communities.

DRYING TECHNOLOGY

AN AGRICULTURAL DRYER IS A DEVICE WHICH REMOVES WATER FROM WET CROPS USING HEAT.

The objective is to reduce moisture levels as rapidly as possible without damaging the commodity and with the least amount of effort and cost. The various means to achieve this objective include **different combinations of design, capacity and energy sources**.

To identify available agricultural drying technology, the research team conducted both desk research and interviews with several technology producers.

The criteria used for this research include:

- **Suitability** for the 10 commodities studied;
- **Availability** in Indonesia or Southeast Asia;
- **Compatibility** with the needs of smallholder farmers in terms of costs, scale and resource requirements.

We collected information on 12 dryers from 10 manufacturers. While these dryers perhaps do not represent all of the drying technology currently available, we felt they best fit the above criteria.

DRYERS:

1. Agrowindo BOX IN-4000 Indirect Dryer
2. Dian Desa Hybrid Solar Dryer
3. GrainPro Solar Bubble Dryer
4. Inovasi Anak Negeri Box Dryer
5. Inovasi Anak Negeri OVE-03 Oven Dryer
6. IPB Rotary Spin Dryer
7. IPB Simple 3-in-1 Dryer
8. Kios Mesin Box Dryer
9. LIPI Multifunction Dryer
10. Nong Lam University Flatbed Dryer
11. Rumah Mesin Cloves Oven Dryer
12. Tanikaya DB1000K Box Dryer

COUNTRIES:

10 Indonesia
1 Vietnam
1 Philippines

AVAILABILITY:

11 commercially available
1 custom order

MANUFACTURERS:

6 companies
2 universities
1 government research institution
1 nonprofit

DRYER SPECIFICATIONS

NAME	PRODUCER	MAXIMUM CAPACITY	MATERIAL	ENERGY SOURCE	AVAILABLE IN
BOX-IN4000 INDIRECT DRYER	**Agrowindo**	4,000 kg	• Axial Blower • Metal Box	• Biomass	Indonesia
HYBRID SOLAR DRYER	**Dian Desa**	200 kg	• Axial Blower • Metal Box	• Sun • Biomass (supplementary)	Indonesia
SOLAR BUBBLE DRYER	**GrainPro**	1,000 kg	• LDPE Cover • PVC	• Sun • Electricity	Philippines
BOX DRYER	**Inovasi Anak Negeri**	100 kg	• Stainless Steel	• Electricity • LPG	Indonesia
OVE-03 OVEN DRYER	**Inovasi Anak Negeri**	50 kg	• Stainless Steel	• Electricity • LPG	Indonesia
ROTARY SPIN DRYER	**Institut Pertanian Bogor**	90 kg	• Axial Blower • Alumunium Flooring	• Biomass • Fuel	Indonesia

NAME	PRODUCER	MAXIMUM CAPACITY	MATERIAL	ENERGY SOURCE	AVAILABLE IN
SIMPLE 3-IN-1 DRYER	**Institut Pertanian Bogor**	N/A	• Copper Pipes • Fins	• Biomass • Sun	Indonesia
BOX DRYER	**Kios Mesin**	150 kg	• Stainless Steel Frame and Wall • Mild Steel Oven	• Biomass • LPG	Indonesia
MULTIFUNCTION DRYER	**LIPI - Prof. Harsisto**	1,000 kg	• Carbon Steel Construct • Stainless Steel and Alumunium Drying Chambers	• Biomass • Electricity (supplementary)	Indonesia
FLATBED DRYER	**Nong Lam University -Vietnam Development Information Center**	8,000 kg	• Axial Blower • Metal Box • Perforated Screen	• Electricity • Diesel	Vietnam
CLOVES OVEN DRYER	**Rumah Mesin**	750 kg	• Axial Blower • Alumunium Flooring	• Biomass • Petrol	Indonesia
TK DB000K BOX DRYER	**TaniKaya and Kubota**	2,000 kg	• Axial Blower • Metal Box	• Biomass	Indonesia

DRYER COVERAGE

Among the 12 dryers reviewed, most rely on multiple sources of energy to heat up the dryer and move air through the device. The five that either **use solar or biomass as the main energy source, without heavy reliance on electricity and fossil fuels, are well suited for rural communities**. Prices and capacities vary considerably depending on manufacturer and model, but overall the prices are prohibitively high for rural, low income smallholder farmers.

✓ main power ✓ supplementary power

DRYER TYPE	PRICE (Rp)*	MAXIMUM CAPACITY (KG)	ENERGY SOURCE			
			ELECTRICITY	FUEL**	BIOMASS***	SUN
AGROWINDO BOX IN-4000 INDIRECT DRYER	53,750,000	4,000			✓	
DIAN DESA HYBRID SOLAR DRYER	30,000,000	200			✓	✓
GRAINPRO SOLAR BUBBLE DRYER	13,300,000	1,000	✓			✓
INOVASI ANAK NEGERI BOX DRYER	17,000,000	100	✓	✓		
INOVASI ANAK NEGERI OVE-03 OVEN DRYER	6,500,000	50	✓	✓		
IPB ROTARY SPIN DRYER	-	90		✓	✓	
IPB SIMPLE 3-IN-1 DRYER	-	N/A			✓	✓
KIOS MESIN BOX DRYER	15,000,000	150		✓	✓	
LIPI MULTIFUNCTION DRYER	75,000,000	1,000	✓		✓	
NONG LAM UNIVERSITY FLATBED DRYER	20,073,750	8,000	✓	✓		
RUMAH MESIN CLOVES OVEN DRYER	35,000,000	750		✓	✓	
TANIKAYA DB1000K BOX DRYER	63,150,000	2,000			✓	

*Prices for IPB's dryers have not been confirmed

** Fuel includes LPG and petrol

***Biomass can be in the form of wood cuttings, wood shavings, rice husks, etc.

Our research shows that **dryers for rice and maize are more readily available, as compared to dryers for plantation crops and spices**. Three dryers produced by Grainpro, Inovasi Anak Negeri, and LIPI claim to be suitable for various commodities but these have not yet been tested. In general, the findings highlight **the need for more dryers to be tested on a wider variation of crops across Indonesia**.

✓ tested ✓ not yet tested

COMMODITY									
MAIZE	RICE	SORGHUM	CACAO	COFFEE	COPRA	CLOVES	GARLIC	PEPPER	VANILLA
✓	✓			✓	✓				
✓	✓	✓	✓	✓		✓	✓	✓	✓
✓	✓								
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
✓	✓	✓							
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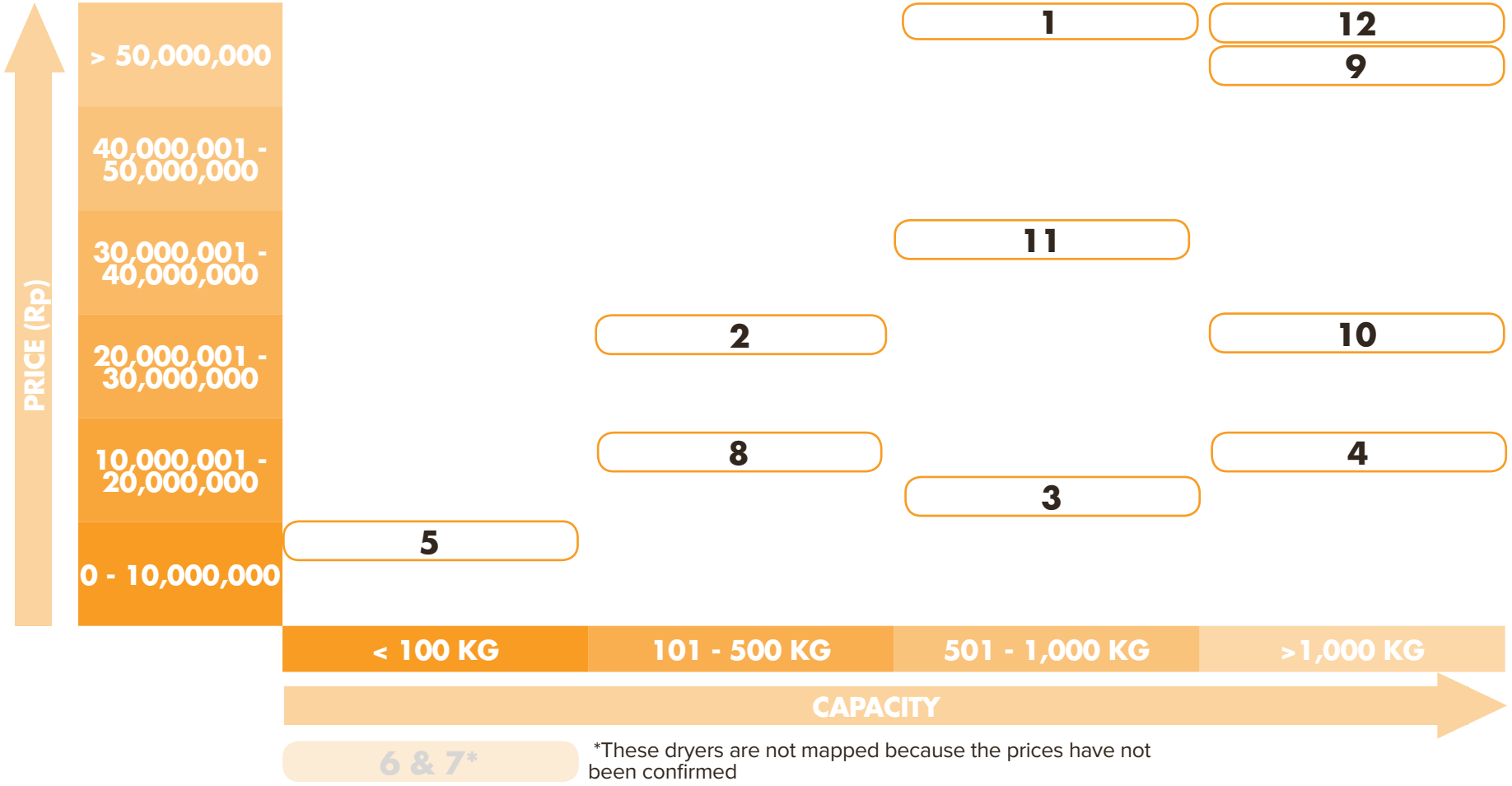
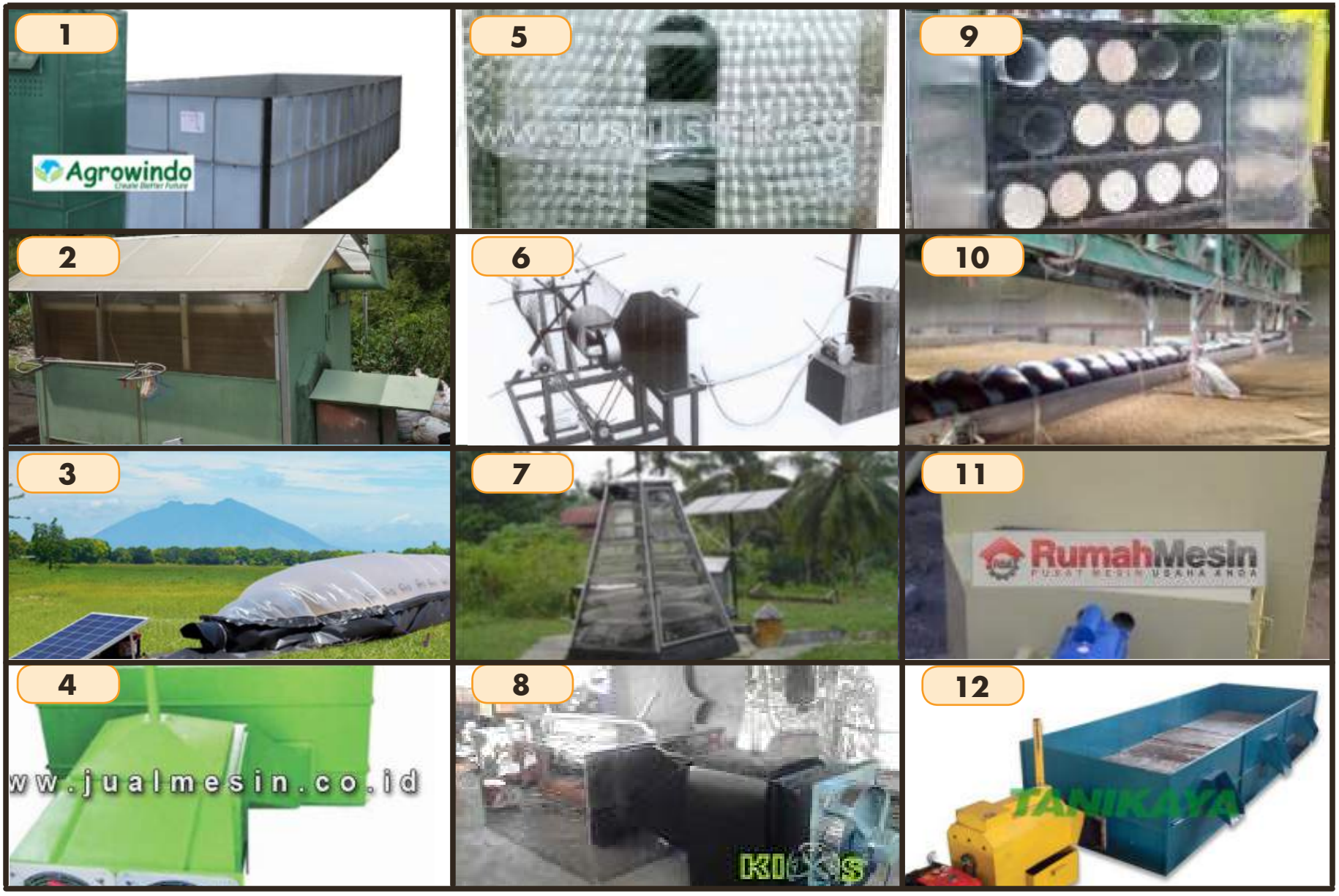
✓	✓	✓	✓	✓	✓	✓		✓	✓
	✓								
						✓			
✓	✓								

DRYER ANALYSIS

When we reviewed the dryers by maximum capacity and price, we see a direct correlation between the two variables - which is expected. What's surprising however, is the **lack of options in the lower left corner and lower middle section that cater to smallholder farmers who could purchase and use dryers as a group**. It should be noted that the dryer capacity required by farmers is heavily dependent on the commodity, yield per harvest, drying speed, and other factors.



*These dryers are not mapped because the prices have not been confirmed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Agrowindo
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TANIKAYA

TO DRY OR NOT TO DRY? THIS IS AN IMPORTANT QUESTION FOR MANY SMALLHOLDER FARMERS AROUND THE WORLD.

Whether or not farmers decide to dry their crops is dependent on many factors which include existing practices, farmer knowledge, access to technology, market forces, weather patterns, to name a few.

Certain commodities must be dried prior to sale

Before delving into the choice between drying and not drying, it should be noted that **certain commodities need to be dried in order for farmers to sell them as there is no demand for them in their raw forms.** Among the 10 studied commodities, three of the spices (pepper, cloves, garlic) and one plantation crop (coffee) fall into this category, at least in the locations where the research was conducted.

For farmers who grow these four crops, effective dryers can minimize damage to the crops caused by ineffective drying practices, which accounts for approximately 5% of loss in volume across the commodities. In other words, **the economic benefit of using dryers would be about 5% with the assumption that they eliminate damage currently caused by poor drying practices.** The adjacent table lists the monetary loss for each commodity as a result of ineffective drying. In other words, these amounts could be recovered with effective drying techniques.

Figure 2: **Commodity loss for a typical farmer due to ineffective drying practices**

COMMODITY	LOSS (%)	MONETARY LOSS (RP) / KG	ANNUAL YIELD (KG)	MONETARY LOSS (RP) / YEAR
Garlic	5%	1,425	667	951,000
Pepper	5%	2,340	302	708,000
Rice	3%	137	3,452	473,000
Cloves	5%	4,020	106	428,000
Maize	6%	113	2,083	236,000
Cacao	4%	504	411	207,000
Vanilla	5%	3,750	38	142,000
Coffee	5%	255	408	104,000
Copra	10%	350	273	95,000
Sorghum	5%	267	320	85,000

However, focusing exclusively on the economic benefit paints an incomplete picture of the wide-ranging advantages that effective drying technology can generate. Below are a few of the benefits that effective drying technology can bring to farmers:

- The crop is enclosed in the dryer and therefore **protected from dust, insects, birds and animals**.
- The higher temperature **reduces the risk of spoilage** by microorganisms; the result is a higher quality crop, which can yield higher selling prices.
- There can be **greater control over timing and duration** of the drying process, giving farmers opportunities to better plan and implement their activities.
- The dryers are **enclosed and waterproof**, therefore the crop

does not need to be moved or covered when it rains.
- There is a **faster drying time**, decreasing labor cost (for labor-intensive commodities like rice and maize) and increasing time to engage in other productive activities.
- Perhaps, most importantly, **improper drying is the root of all evil that contributes to further losses** in subsequent post-harvest processes like processing and storing.

All of these are significant benefits of improving existing drying practices, which are even bigger than the small but not insignificant economic benefits of doing so.

COMMODITIES THAT CAN BE SOLD UNDRIED

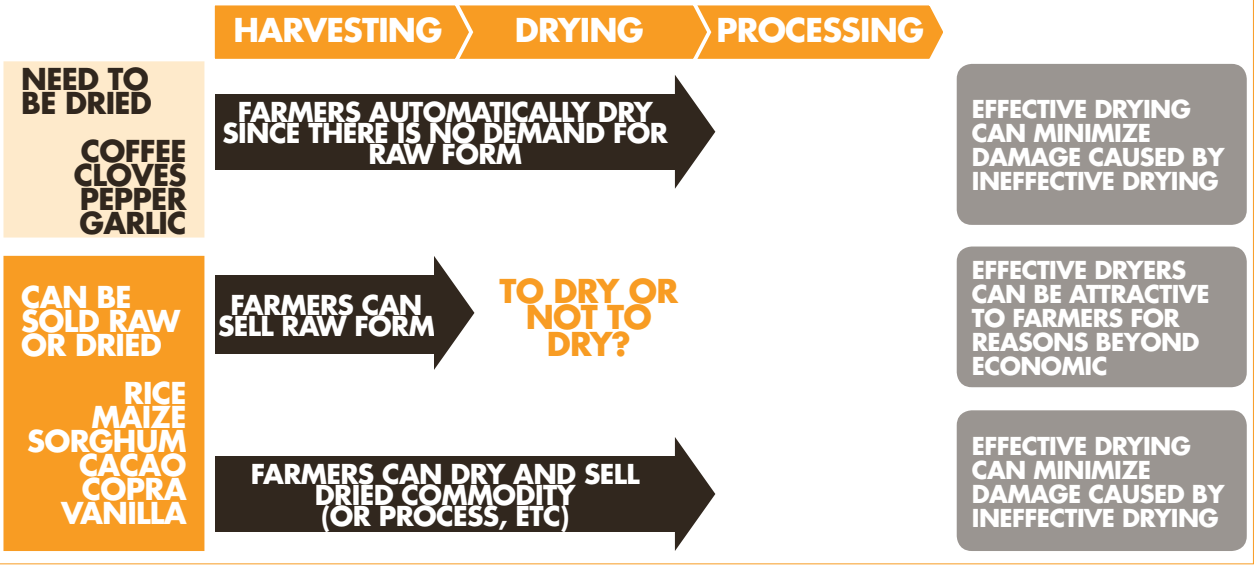
For the other six commodities (rice, maize, sorghum, cacao, copra, vanilla), farmers must decide whether to dry or not to dry. The decision-making process for this question differs for each commodity and location, and is influenced by a myriad of internal and external factors.

For example, many farmers are engaged in cultivating a certain commodity because it has been done this way for generations, relying on the same process for decades. They may even continue to sell their crops to the same buyer (or his family) from generation to generation. For such farmers, changing the current practice requires not only financial incentives, but also information, demonstration, tools, guidance, and perhaps a nudge.

Even if the economic benefit of drying is clear, farmers may still choose to sell their commodities raw because they need cash immediately, do not want to bother with the effort of drying, face challenging or uncertain weather conditions, and/or do not have access to buyers who would buy the crop in its dried form.

In other words, it's complicated. And given the complexity, we have not been able to calculate the economic benefit of shifting from non-drying to drying (using effective methods). Such an exercise would require more in-depth interviews with farmers, plus many more data points and assumptions to be made.

Figure 3: **To dry or not to dry**



BENEFITS OF DRYING

OUR RECOMMENDATION: COMMUNAL DRYING FOR ALL COMMODITIES.

During our research, we learned that while drying is a complicated process, improving it will bring significant benefits for farmers. We also discovered that given the nature of drying, ownership of effective dryers at the individual farmer level may not be economically feasible or necessary. Instead, we recommend that effective dryers are purchased and used at the communal - or farmer group/cooperative level - similar to mills and other processing equipment. Below, using the example of cloves, we explain how the economics of investing in shared drying machinery could look.

The additional annual income gained from switching from the current drying practice to a more efficient drying method of cloves is roughly US$33 for a smallholder farmer. With farmers' average monthly income in Indonesia being around US$42 per capita, a more efficient drying method will earn the farmer ¾ of an additional month's income. This extra income does not include any of the additional benefits of shifting to an improved drying method mentioned earlier. It is the calculation of only the direct loss due to damage caused by inefficient drying. It is likely that a more comprehensive calculation that included the other factors would yield a higher increase in annual income.

Based on our research of 12 dryers, the average cost of a dryer is about US$2,550. Given this finding, it would take an average-sized farmer cooperative of 26 farmers to repay the upfront cost of the dryer in a period of around three years. As this number of farmers is too large to be effectively served by a medium-sized dryer, we recommend capping the number of farmers per dryer at 10. If we keep the repayment period the same, the dryer would need to cost at most US$1,000. This is less than half of the average cost of the dryers that are currently available on the market.

Our recommendation is therefore to develop communal dryers that serve around 10 farmers at a price range of approximately US$1,000. Even at this more affordable level, there will be a need to explore financing mechanisms including partnerships with financial institutions to ensure farmers can access such dryers, or seeking funding from the village fund (dana desa) and other ways.

The other possibility would be to develop and test a business model that allows for the rental of dryers on a pay-as-you-go basis for farmers, while establishing a mechanism to manage the use of the dryers and cover running costs so that it could run in a financially sustainable way.

OUR RECOMMENDATION IS THEREFORE TO DEVELOP COMMUNAL DRYERS THAT SERVE AROUND 10 FARMERS AT A PRICE RANGE OF APPROXIMATELY US$1,000.

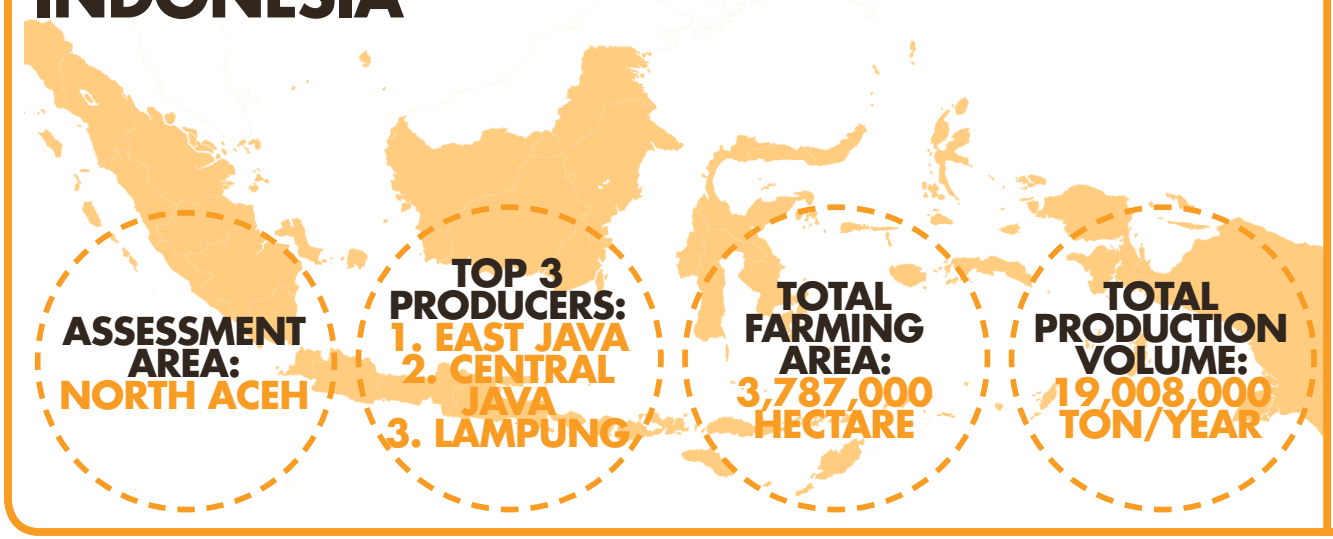
THE OTHER POSSIBILITY WOULD BE TO DEVELOP AND TEST A BUSINESS MODEL THAT ALLOWS FOR THE RENTAL OF DRYERS ON A PAY-AS-YOU-GO BASIS FOR FARMERS.

MAIZE

Maize is consumed by both humans and livestock. Indonesian maize consumption continues to outpace domestic maize production which is seasonally inconsistent, with production peaking in March and April. Poor post-harvest management results in high moisture and aflatoxin levels, as well as damaged kernels, mostly caused by exposure to rain during the drying process.

WORLD

INDONESIA



SMALLHOLDER FARMERS

A typical maize farmer in Indonesia:

LAND AREA OF HARVEST
0.43 HA/FARMER

YIELD PER FARMER
2,083 KG/YEAR

VALUE CHAIN

PRE-HARVEST

SEEDING

7-15 DAYS

STEPS:

- The seeds are planted (approx. 20kg for 1 ha) after soil cultivation.
- Best soil for growing maize is where rice has previously grown.

GROWING

3-4 MONTHS

STEPS:

- Seedlings are replanted 2 weeks after seeding at larger intervals.
- Weeding is performed twice, at 15 days and 28-30 days after planting.
- Fertilizer, insecticides, and fungicides are applied to boost growth and protect the stalks.

CHALLENGES:

- **Seed dilemma:** Farmers are reluctant to use subsidized seed provided by the government due to the lower quality of the subsidized seed compared to commercially available seed. However, commercial seed is considered too expensive by farmers.
- **Pests:** Often pests present a threat to young cornstalks.

HARVEST

HARVESTING

1-2 DAYS

STEPS:

- Maize is harvested once the black layer at the kernel tip appears and the husk is no longer covering the ear.
- Frequency: usually 3 times a year (but depends on the field type).
- Timing: March, April, or August.

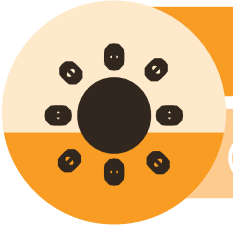
MARKET PRICE: Rp 1,800/kg	WEIGHT: 100%

CHALLENGES:

- **Lack of technology access:** Maize pickers, maize shellers and other mechanical tools exist, and this technology can decrease harvesting costs by up to 30% compared to manual processes. However, most farmers do not have access to these non-manual harvesting tools.

POST-HARVEST

DRYING



4 WEEKS & 4-5 DAYS

STEPS:

- After pre-harvest drying, corn husk is removed and ears are dried for 2 days.
- Ears are cut from stalk and dried under the sun. Rotten ears are removed.
- The moisture level is 35-40% before drying and 12-14% after drying.

MARKET PRICE:	WEIGHT:	LOSS:
Rp 2,700/kg	70%	6%

PROCESSING

1-2 DAYS

STEPS:

- Maize is shelled by removing the kernels from the corn ear.
- Kernels are dried for 1 day.
- The kernels are sorted and those that are broken or rotten are removed.

MARKET PRICE:
Rp 4,400/kg

STORING

3 MONTHS

STEPS:

- Corn ears and kernels are often stored in sacks in farmers' houses.
- Corn ears generally last longer than kernels.
- A wooden base (~5-10cm from the ground) is needed to ensure the air circulates under the sacks to avoid mold.

CHALLENGES:

- **Weather during drying:** Heavy rainfall causes the kernels to rot, while inefficient drying processes tend to result in lower quality corn kernels.
- **Contamination during storage:** Mold creates musty smell, weight loss, a decrease in the nutrient composition and leads to mycotoxin contamination. Rodent feces contaminate the grain.

DRYER NEEDS

As described in the previous page, drying maize involves specific steps and challenges. In particular, the moisture level needs to be reduced from 35-40% to 12-14% without damaging the commodity, and with the least amount of effort and cost.

While several dryers can be used for maize, their average price of Rp. 35 million (US$ 3,000) is very high for smallholder farmers. Also, there is only one option that uses solar power as the main energy source (Grainpro's Solar Bubble), thus running cost is something to consider for the other technologies.

✓ main power ✓ supplementary power ✓ tested ✓ not yet tested

DRYER TYPE	PRICE (Rp)*	MAXIMUM CAPACITY (KG)	ENERGY SOURCE				MAIZE
			ELECTRICITY	FUEL**	BIOMASS***	SUN	
AGROWINDO BOX IN-4000 INDIRECT DRYER	53,750,000	4,000			✓		✓
GRAINPRO SOLAR BUBBLE DRYER	3,300,000	1,000	✓			✓	✓
INOVASI ANAK NEGERI BOX DRYER	17,000,000	100	✓	✓			✓
INOVASI ANAK NEGERI OVE-03 OVEN DRYER	6,500,000	50	✓	✓			✓
IPB ROTARY SPIN DRYER	-	90		✓	✓		✓
IPB SIMPLE 3-IN-1 DRYER	-	N/A			✓	✓	✓
KIOS MESIN BOX DRYER	15,000,000	150		✓	✓		✓
LIPI MULTIFUNCTION DRYER	75,000,000	1,000	✓		✓		✓
TANIKAYA DB1000K BOX DRYER	63,150,000	2,000			✓		✓

*Prices for IPB's dryers have not been confirmed

** Fuel includes LPG and petrol

***Biomass can be in the form of wood cuttings, wood shavings, rice husks, etc.

OPPORTUNITIES & BENEFITS

Given the unmet need in effective dryers for maize, Kopernik calls for a cross-sectoral effort to develop and test prototypes with a longer term goal to improve the livelihoods of smallholder farmers.

Meeting this need with an effective dryer would bring the following benefits to smallholder farmers:

ECONOMIC IMPACT	Compared to traditional methods, an effective dryer can generate an additional **Rp 236,000 / year** for a typical farmer
OTHER BENEFITS	• **Higher quality** of crop • **Faster** drying time • Greater **control** over drying timing • **Reduced loss** during processing and storing (For more details, please refer to the 'Benefits of Drying' section)

The market size of this unmet need is estimated at:

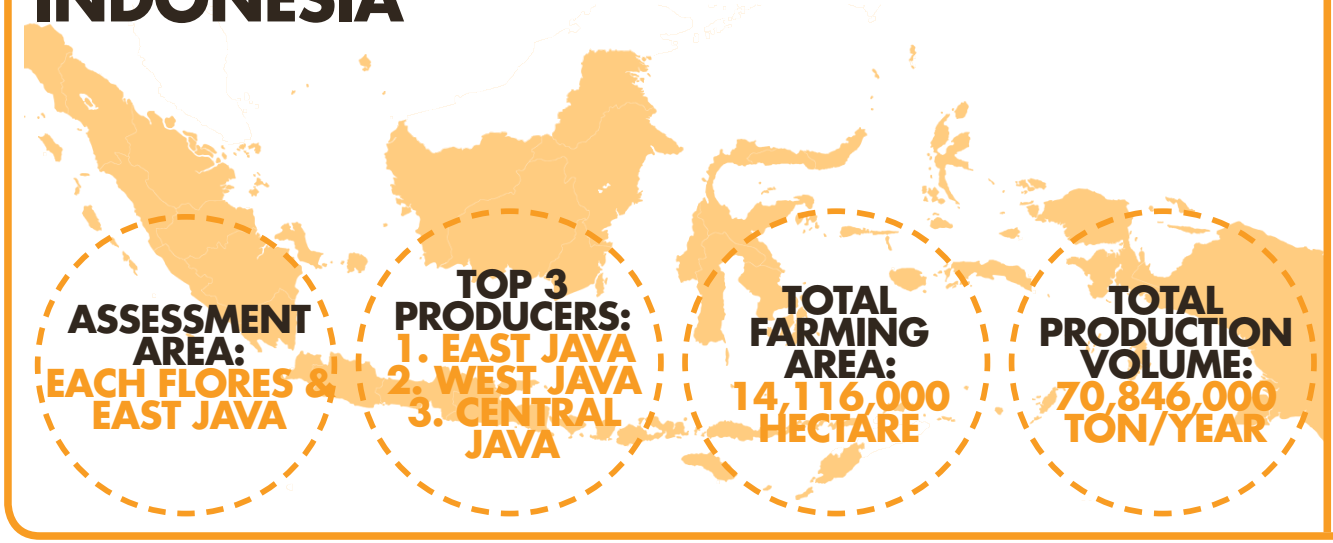
MARKET OPPORTUNITY	**MARKET SIZE OF DAMAGE DUE TO INEFFECTIVE DRYING (RETAIL PRICE)** **Rp 8.0 TRILLION** **US$ 614 MILLION**

RICE

Rice, an Indonesian staple is consumed at an average of 97kg per person, per year. While challenges in the farming of rice exist along the entire value chain, ineffective drying techniques and pest infestation can result in losses of 3% on average. Undried rice grains attract more pests, leading to a 5-10% loss. The total post-harvest process loss for rice is around 25%.

WORLD

INDONESIA



SMALLHOLDER FARMERS

A typical rice farmer in Indonesia:

LAND AREA OF HARVEST
0.67 HA/FARMER

YIELD PER FARMER
3,452 KG/YEAR

VALUE CHAIN

PRE-HARVEST

SEEDING

8-25 DAYS

STEPS:

- Plant seeds after soil cultivation, either in a polybag or directly in the rice field.
- Tractors are widely used to cultivate soil.

GROWING

4 MONTHS

STEPS:

- Seedlings are re-planted.
- Fertilizer (up to 300kg for 500m2 rice field), pesticides and brush cutter are widely used in this step to enhance growth, and protect plants from weeds and pests.

CHALLENGES:

- **Weather:** Drought and heavy rain can change crop cycle timing. Freshly seeded fields tend to have poor distribution and germination if exposed to rainfall (IRRI).
- **Tool access:** Ruler-like planting tools to ensure ideal plant spacing are not widely available
- **Pests:** Rodents and *walang sangit* (rice ear bugs) can cause significant loss (up to ~10%)
- **High expenditure:** Farmers use various high cost fertilizers. Subsidized fertilizer is not available and/or limited to a certain volume per province

HARVEST

HARVESTING

1-2 DAYS

STEPS:

- The rice is harvested manually and threshed.
- Frequency of harvesting is typically 2-3 times a year (depending on type of field).
- Time for harvesting varies, most commonly taking place in March, April, and August.

MARKET PRICE: Rp 4,000 - 4,500/kg	WEIGHT: 100%

CHALLENGES:

- Non-optimal harvest time leads to lower quality and grain losses of up to 10% of the total harvest.
- Late threshing process causes ~5% in losses. Farmers thresh paddy conventionally using a threshing board; though simple mechanical threshers are available for rent.

POST-HARVEST

DRYING

1-3 DAYS

STEPS:

- Unhulled rice is usually dried by spreading it on top of plastic tarpaulin and placing under the sun.
- The moisture level is on average 25% before drying, and 13% after drying.

MARKET PRICE:	WEIGHT:	LOSS:
Rp 5,400/kg	83%	3%

PROCESSING

0-1 DAYS

STEPS:

- Rice is milled at a personal mill or at a milling business.
- Many farmers sell their freshly-harvested rice grain to mills to avoid the drying process, and to get money more quickly.
- In this scenario the mills are also collectors, as they buy rice directly from farmers.

STORING

4 MONTHS

STEPS:

- Smallholder farmers usually sell their commodities immediately to collectors/ mills, but those with a larger amount of rice often store it at home or in a storage room.
- A wooden base (~5-10cm from the ground) is needed to ensure air circulates under the rice sacks to avoid mold.

CHALLENGES:

- **Inefficient drying:** the drying process causes 1-5% in losses due to process inefficiency and variable weather patterns.
- Setting the mill blower too strong can lead to up to 5% loss.
- Unhygienic mills can attract weevils and mold.
- Weevils, rats and rodents tend to infest rice during storage (especially rice stored for more than 4 months). In Indonesia, storage losses account for 1%, while ASEAN countries show a higher loss of 5-10% on average.

DRYER NEEDS

As described in the previous page, drying rice involves specific steps and challenges. In particular, the moisture level needs to be reduced from 25% to 13% without damaging the commodity and with the least amount of effort and cost.

While several dryers can be used for rice, their average price of Rp. 35 million (US$ 3,000) is very high for smallholder farmers. Also, there is only one option that uses solar power as the main energy source (Grainpro's Solar Bubble), thus running cost is something to consider for the other technologies.

✓ tested
✓ not yet tested

✓ main power ✓ supplementary power

DRYER TYPE	PRICE (Rp)*	MAXIMUM CAPACITY (KG)	ENERGY SOURCE				RICE
			ELECTRICITY	FUEL**	BIOMASS***	SUN	
AGROWINDO BOX IN-4000 INDIRECT DRYER	53,750,000	4,000			✓		✓
GRAINPRO SOLAR BUBBLE DRYER	13,300,000	1,000	✓			✓	✓
INOVASI ANAK NEGERI BOX DRYER	17,000,000	100	✓	✓			✓
INOVASI ANAK NEGERI OVE-03 OVEN DRYER	6,500,000	50	✓	✓			✓
IPB ROTARY SPIN DRYER	-	90		✓	✓		✓
IPB SIMPLE 3-IN-1 DRYER	-	N/A			✓	✓	✓
KIOS MESIN BOX DRYER	15,000,000	150		✓	✓		✓
LIPI MULTIFUNCTION DRYER	75,000,000	1,000	✓		✓		✓
NONG LAM UNIVERSITY FLATBED DRYER	20,073,750	8,000	✓	✓			✓
TANIKAYA DB1000K BOX DRYER	63,150,000	2,000			✓		✓

*Prices for IPB's dryers have not been confirmed

** Fuel includes LPG and petrol

***Biomass can be in the form of wood cuttings, wood shavings, rice husks, etc.

OPPORTUNITIES & BENEFITS

Given the unmet need in effective dryers for rice, Kopernik calls for a cross-sectoral effort to develop and test prototypes with a longer term goal to improve the livelihoods of smallholder farmers.

Meeting this need with an effective dryer would bring the following benefits to smallholder farmers:

ECONOMIC IMPACT	Compared to traditional methods, an effective dryer can generate an additional **Rp 473,000 / year** for a typical farmer
OTHER BENEFITS	• **Higher quality** of crop • **Faster** drying time • Greater **control** over drying timing • **Reduced loss** during processing and storing (For more details, please refer to the 'Benefits of Drying' section)

The market size of this unmet need is estimated at:

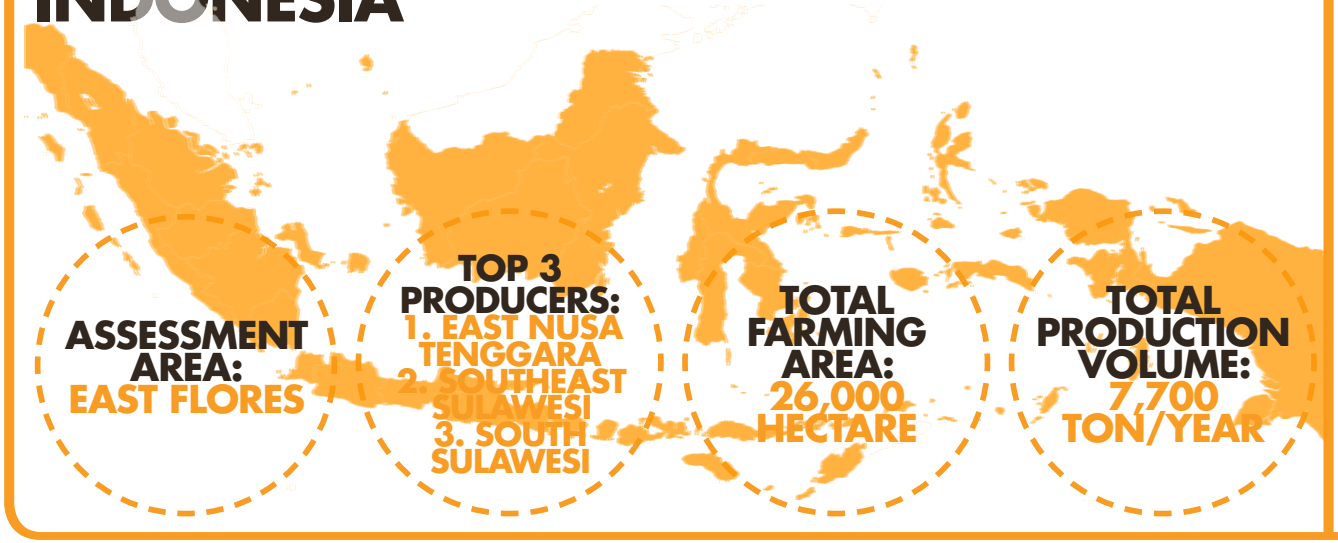
MARKET OPPORTUNITY	**MARKET SIZE OF DAMAGE DUE TO INEFFECTIVE DRYING (RETAIL PRICE)** **Rp 22.8 TRILLION** **US$ 1.74 BILLION**

SORGHUM

Sorghum, a cereal crop with high protein content, is less popular than rice or maize. Sorghum offers high potential in Indonesia, growing best in dry climates at ~32ºC. Outside the country, it is mostly used as feed in the poultry industry. The low selling-price, caused by unstable demand and inefficient post-harvest management, is the main challenge faced by farmers of this commodity.

WORLD

INDONESIA



SMALLHOLDER FARMERS

A typical rice farmer in Indonesia:

LAND AREA OF HARVEST
0.15 HA/FARMER

YIELD PER FARMER
320 KG/YEAR

VALUE CHAIN

PRE-HARVEST

SEEDING

2-3 WEEKS

STEPS:

- Seeds are planted (~10-15kg of seeds/ha) 5cm deep.
- Soil cultivation is needed to enhance the water circulation process in the ground.
- The crop cycle starts right after the end of the rainy season.

GROWING

3-6 MONTHS

STEPS:

- The seedlings are transplanted.
- Fertilizer is applied. The type depends on location but generally sorghum responds best to nitrogen-based fertilizer.
- Fungicides and herbicides are applied to protect the plant from weeds and mold, caused by fluctuating temperature and humidity levels.

CHALLENGES:

- **Seed problem:** Farmers have limited knowledge of the best variety of seed and amount of seed to use.
- **Weather:** Sorghum grows well in dry areas as compared to other crops, but still needs water and nutrients to thrive. Acute dry season and extreme drought lower its productivity. Fluctuations in temperature and high humidity levels causes the grains to spoil.
- **Pests and contamination:** Because they have no husk, sorghum ears are easy targets for birds, mold, and pests.

HARVEST

HARVESTING

1-2 DAYS

STEPS:

- The stalk is cut with a machete. Sorghum can regenerate after cutting the stalks and harvesting the grain (ratoon crop). It can be harvested for 2-3 crop cycles. The plant will be ready for harvest again after 2 months.

MARKET PRICE: Rp 1,500 - 2,000/kg	WEIGHT: 100%

CHALLENGES:

- **Non-optimal harvest time:** Late harvesting lowers the quality of sorghum, especially in humid weather.

POST-HARVEST

DRYING

5-7 DAYS

STEPS:

- Unhulled rice is usually dried by spreading it on top of plastic tarpaulin and placing under the sun.
- The moisture level is on average 25% before drying, and 13% after drying.

MARKET PRICE:	WEIGHT:	LOSS:
N/A	89%	5%

PROCESSING

15 KG/ HOUR

STEPS:

- The grains are usually manually pounded or threshed. Mechanical tools are available in limited areas.

MARKET PRICE:
Rp 6,000/kg

STORING

8-12 MONTHS

STEPS:

- The grain is stored in simple sacks for consumption or shipping and selling. Some farmers hang the unthreshed sorghum ears in front of their houses exposed to the elements.

CHALLENGES:

- **Inefficient drying and lack of technology access:** Drying technology can save up to 5 days in drying time, but it is not widely available for smallholder farmers. Thus drying time highly depends on the weather. Ineffective drying results in broken grains (during processing) or mold (during storage).
- **Threshing:** Farmers find it difficult to thresh sorghum grains manually due to hard texture of the grains.
- **Contamination during storage:** Sorghum stored in sacks is often infested by weevils, other pests, and mold. The losses can be up to 30% after only 3 months of storage.

DRYER NEEDS

As described in the previous page, drying sorghum involves specific steps and challenges. In particular, the moisture level needs to be reduced from 25% to 13% without damaging the commodity and with the least amount of effort and cost.

Among the 12 dryers reviewed, the following brands cater to drying sorghum – either tested or claimed to be applicable by the manufacturer. As the short list demonstrates, a few commercially available dryers can expedite the drying process effectively. They vary substantially in terms of capacity, price, and heating mechanism. Regardless, there is a clear need for more prototypes to be developed and more testing to be conducted.

✓ main power ✓ supplementary power ✓ tested ✓ not yet tested

DRYER TYPE	PRICE (Rp)*	MAXIMUM CAPACITY (KG)	ENERGY SOURCE				SORGHUM
			ELECTRICITY	FUEL**	BIOMASS***	SUN	
GRAINPRO SOLAR BUBBLE DRYER	13,300,000	1,000	✓			✓	✓
INOVASI ANAK NEGERI OVE-03 OVEN DRYER	6,500,000	50	✓	✓			✓
IPB ROTARY SPIN DRYER	-	90		✓	✓		✓
LIPI MULTIFUNCTION DRYER	75,000,000	1,000	✓		✓		✓

*Prices for IPB's dryers have not been confirmed

** Fuel includes LPG and petrol

***Biomass can be in the form of wood cuttings, wood shavings, rice husks, etc.

OPPORTUNITIES & BENEFITS

Given the unmet need in effective dryers for sorghum, Kopernik calls for a cross-sectoral effort to develop and test prototypes with a longer term goal to improve the livelihoods of smallholder farmers.

Meeting this need with an effective dryer would bring the following benefits to smallholder farmers:

ECONOMIC IMPACT	Compared to traditional methods, an effective dryer can generate an additional **Rp 85,000 / year** for a typical farmer
OTHER BENEFITS	• **Higher quality** of crop • **Faster** drying time • Greater **control** over drying timing • **Reduced loss** during processing and storing (For more details, please refer to the 'Benefits of Drying' section)

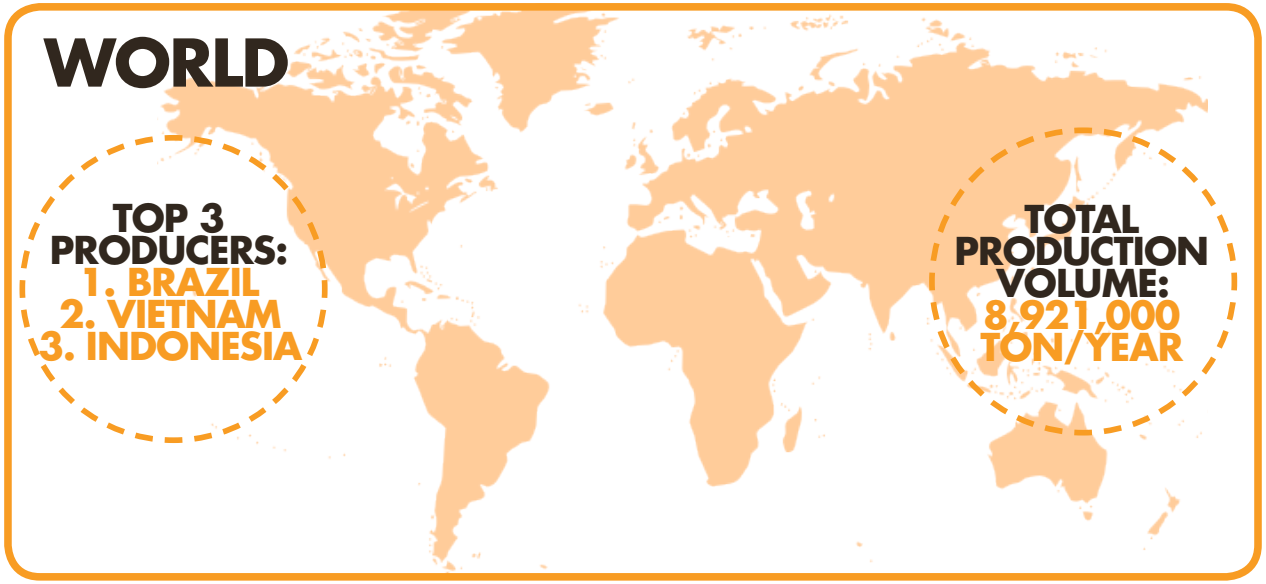
The market size of this unmet need is estimated at:

MARKET OPPORTUNITY	**MARKET SIZE OF DAMAGE DUE TO INEFFECTIVE DRYING (RETAIL PRICE)** **Rp 2.31 BILLION** **US$ 176,000**

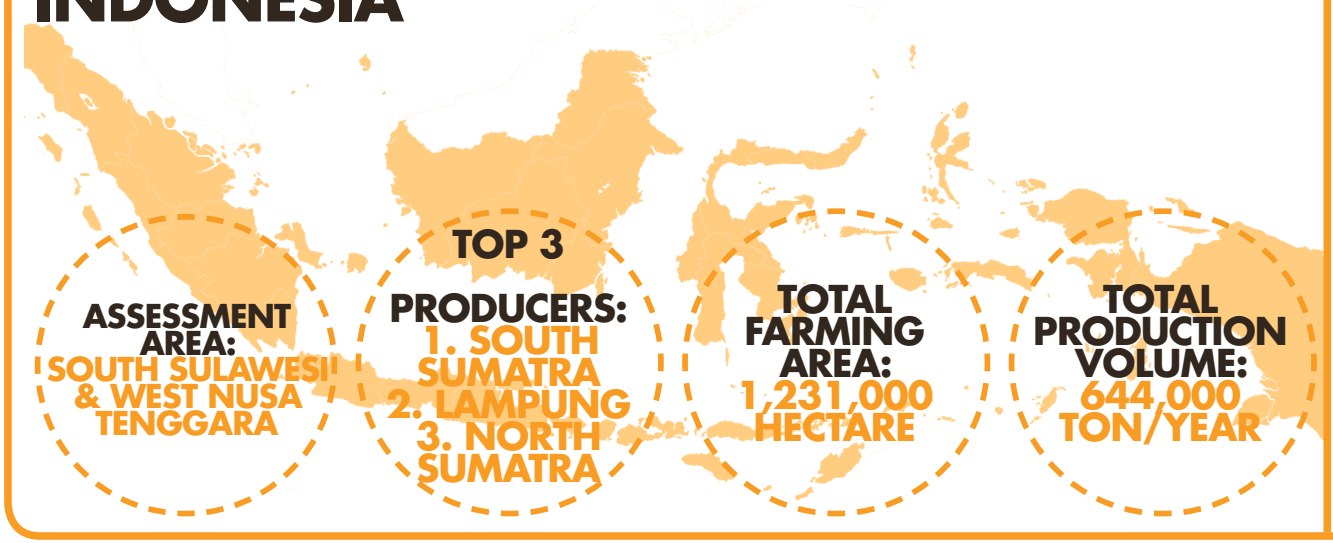
ARABICA COFFEE

Arabica coffee is more expensive than other variants available on the world market. In 2014, Indonesian coffee plantations covered approximately 1.24 million hectares, of which 20% was the Arabica variety. With 90% of coffee plantations being cultivated by smallholder farmers, the main challenges are variations in weather, making drying challenging, and a lack of processing facilities.

WORLD



INDONESIA



SMALLHOLDER FARMERS

A typical arabica coffee farmer in Indonesia:

LAND AREA OF HARVEST
0.54 HA/FARMER

YIELD PER FARMER
408 KG/YEAR

VALUE CHAIN

PRE-HARVEST

SEEDING

5 MONTHS

STEPS:

- Coffee seed is planted in sand (depth 0.5 cm).
- The sand area is covered with mulch and is watered daily.
- Once sprouted, the plant is moved to a polybag.
- After 3-5 months, the seedlings are moved to the field.

GROWING

3-4 YEARS

STEPS:

- The branches of plants that have produced fruit 3-5 times are removed.
- Plants are kept short (170 cm) to allow for increased sunlight and to avoid humid conditions, which attract pests.
- Land is fertilized twice a year.

CHALLENGES:

- **Low productivity:** The most productive time to cultivate the plants is at around 7-9 years. However, continuous cultivation of old coffee plants and often poor maintainance results in low productivity of the crop.
- **Quality and type of seeds:** Although Arabica coffee attracts a higher price, 80% of farmers continue to plant robusta varieties, as they are unaware of the market demand for this better quality product.
- **Weather:** Unpredictable rainy seasons may delay the planting process.

HARVEST

HARVESTING

10-14 DAYS, EVERY 4-5 MONTHS

STEPS:

- Harvesting time ranges from 10-14 days and occurs every 4-5 months.
- The fruit is sorted by color (red, yellow, green) and quality (perfect shape, not broken or infected by pests).
- The fruit is peeled using a peeling machine.

MARKET PRICE: Rp 4,500/kg	WEIGHT: 100%

CHALLENGES:

- **Weather:** Heavy rains during harvest period can prolong the harvest process, as it is more difficult and unpleasant to pick the coffee. Prolonged periods of rain can also decrease the quality of coffee, or even ruin it completely.

POST-HARVEST

DRYING

2-3 WEEKS

STEPS:

- The beans are laid out on cement floor or tarpaulin, and regularly rotated for even drying.
- The moisture level is 55-60% before drying and 10-12% after drying.

MARKET PRICE: Rp 21,000 - 30,000/ kg	WEIGHT: 17%	LOSS: 3-5%

PROCESSING

0-1 DAY

STEPS:

- The husk is removed using a huller to minimize the risk of damage to the bean.
- Sorting is done by separating out the broken beans and removing dirt.

STORING

VARIES

STEPS:

- The beans are packed, ready to be distributed to a coffee collector or manufacturer. The roasting is usually done by the manufacturer.

CHALLENGES:

- **Inefficient drying:** There are variances in drying times depending on the weather. During cold weather conditions, coffee takes a longer time to dry and this encourages mold growth.
- **Storage methods:** Storing beans in sacks is prone to infestation by insects. Additionally, many defective beans are stored together with good beans and this leads to a reduction of overall quality.

DRYER NEEDS

As described in the previous page, drying coffee involves specific steps and challenges. In particular, the moisture level needs to be reduced from 55-60% to 10-12% without damaging the commodity and with the least amount of effort and cost.

Among the 12 dryers reviewed, the following brands cater to drying coffee – either tested or claimed to be applicable by the manufacturer. As the short list demonstrates, a few commercially available dryers can expedite the drying process effectively. They vary substantially in terms of capacity, price, and heating mechanism. Regardless, there is a clear need for more prototypes to be developed and more testing to be conducted.

✓ main power ✓ supplementary power ✓ tested ✓ not yet tested

DRYER TYPE	PRICE (Rp)	MAXIMUM CAPACITY (KG)	ENERGY SOURCE				COFFEE
			ELECTRICITY	FUEL*	BIOMASS**	SUN	
AGROWINDO BOX IN-4000 INDIRECT DRYER	53,750,000	4,000			✓		✓
GRAINPRO SOLAR BUBBLE DRYER	13,300,000	1,000	✓			✓	✓
INOVASI ANAK NEGERI OVE-03 OVEN DRYER	6,500,000	50	✓	✓			✓
KIOS MESIN BOX DRYER	15,000,000	150		✓	✓		✓
LIPI MULTIFUNCTION DRYER	75,000,000	1,000	✓		✓		✓

*Fuel includes LPG and petrol

**Biomass can be in the form of wood cuttings, wood shavings, rice husks, etc.

Given the unmet need in effective dryers for coffee, Kopernik calls for a cross-sectoral effort to develop and test prototypes with a longer term goal to improve the livelihoods of smallholder farmers.

Meeting this need with an effective dryer would bring the following benefits to smallholder farmers:

ECONOMIC IMPACT	Compared to traditional methods, an effective dryer can generate an additional **Rp 104,000 / year** for a typical farmer
OTHER BENEFITS	• **Higher quality** of crop • **Faster** drying time • Greater **control** over drying timing • **Reduced loss** during processing and storing (For more details, please refer to the 'Benefits of Drying' section)

The market size of this unmet need is estimated at:

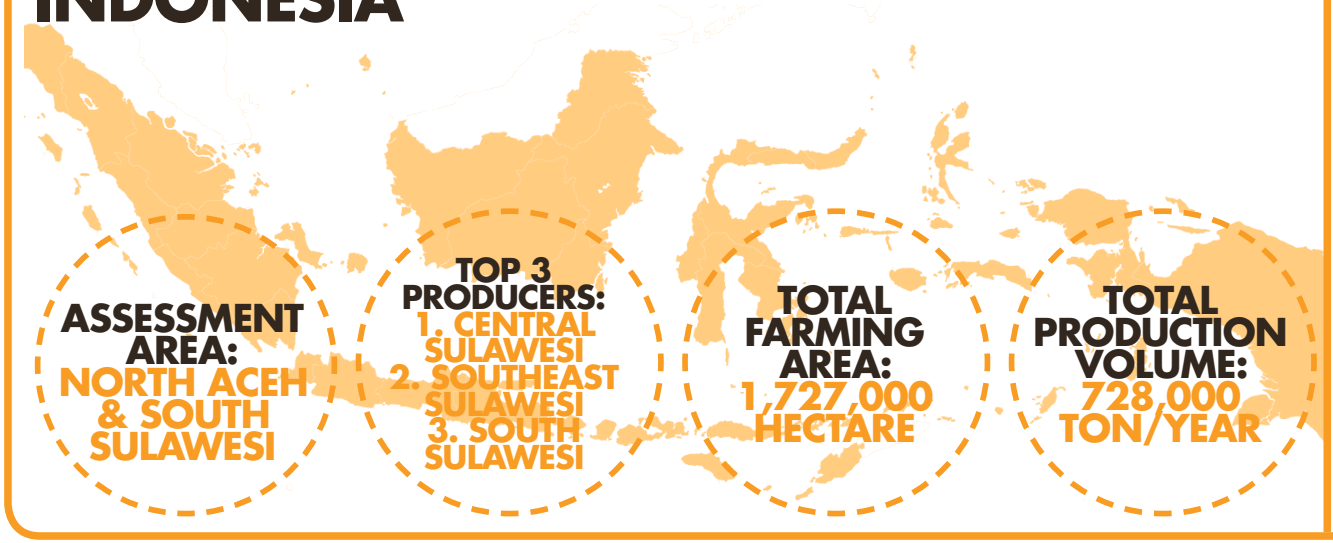
MARKET OPPORTUNITY	**MARKET SIZE OF DAMAGE DUE TO INEFFECTIVE DRYING (RETAIL PRICE)** **Rp 1.4 TRILLION** **US$ 109 MILLION**

CACAO

Indonesia is the world's third largest cacao producer after the Ivory Coast and Ghana. 70%, of Indonesia's cacao is produced in Sulawesi, followed by North Sumatra, West Java, Papua, and East Kalimantan. Unlike industrialized crops, 80-90% of cacao comes from small family-run farms, where farmers often have limited knowledge of modern farming techniques and farm management skills, including drying and fermenting the beans.

WORLD

INDONESIA



SMALLHOLDER FARMERS

A typical cacao farmer in Indonesia:

LAND AREA OF HARVEST
0.50 HA/FARMER

YIELD PER FARMER
411 KG/YEAR

VALUE CHAIN

PRE-HARVEST

SEEDING

4-5 DAYS & 4-6 MONTHS

STEPS:

- Unbroken seed is taken from the fruit and dried.
- The seeds are planted and the seedlings are moved to a polybag with soil, fertilizer, and sand to prevent them from being overexposed to sun, rain, and wind.

GROWING

1 YEAR

STEPS:

- The seedlings are transplanted after 4-6 months to ~0.5m3 holes with 2.5-3m space in between. 3-5 kg of fertilizer is used for each.
- The holes are prepared 2 months before transplanting to increase soil oxygen levels.

CHALLENGES:

- **Environmental concerns:** Soil fertility levels degrade over time. There is a need to rejuvenate cacao plantations through composting and agroforesty techniques.
- **Education level:** Low levels of education among farmers is a critical issue affecting farming practices and business decisions.

HARVEST

HARVESTING

2 DAYS

STEPS:

- The fruit is cut from the tree.
- The cacao fruit is split to get the beans, which are covered by a white pulp.

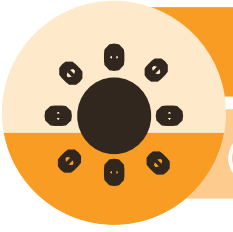
MARKET PRICE: Rp 5,000/kg	WEIGHT: 100%

CHALLENGES:

- **Low productivity:** Farmers often have limited knowledge and access to modern farming techniques, management skills and capital to purchase input supplies and good quality planting materials.
- **Aging trees:** Trees that are past their peak production will have a lower yield, and attract pests and disease.

POST-HARVEST

DRYING



40 HOURS

STEPS:

- Sun-drying is the most common method used. The beans - still covered by a white pulp - are placed on a tarpaulin. Ideal temperature for drying is 50-55ºC.
- The moisture level is 55% before drying and 7% after drying.

MARKET PRICE:	WEIGHT:	LOSS:
N/A	36%	4%

PROCESSING

5-6 DAYS

STEPS:

- Most farmers perform manual fermentation by keeping the beans in sacks for 2 days after drying, and then drying the fermented beans again afterwards.
- The beans are sorted based on size (small, medium, large) and whole beans versus cracked beans.

MARKET PRICE: Rp 35,000/kg

STORING

VARIES

STEPS:

- The beans are usually stored in gunny sacks. Some farmers don't like to store their beans for a long time and prefer to sell them right away.

CHALLENGES:

- **Pests and disease:** In the three major growing regions, an estimated 30-40% of the crop is lost due to pests and disease.
- **Inefficient drying practices:** Drying time is important. A longer drying time will result in moldy beans, while drying too fast will interfere with the fermentation process, which also occurs during drying. Incorrect drying processes can cause high acidity in the beans, which reduces the quality.

DRYER NEEDS

As described in the previous page, drying cacao involves specific steps and challenges. In particular, the moisture level needs to be reduced from 55% to 7% without damaging the commodity and with the least amount of effort and cost.

Among the 12 dryers reviewed, the following brands cater to drying cacao – either tested or claimed to be applicable by the manufacturer. As the short list demonstrates, a few commercially available dryers can expedite the drying process effectively. They vary substantially in terms of capacity, price, and heating mechanism. Regardless, there is a clear need for more prototypes to be developed and more testing to be conducted.

✓ main power ✓ supplementary power ✓ tested ✓ not yet tested

DRYER TYPE	PRICE (Rp)	MAXIMUM CAPACITY (KG)	ENERGY SOURCE				CACAO
			ELECTRICITY	FUEL*	BIOMASS**	SUN	
GRAINPRO SOLAR BUBBLE DRYER	13,300,000	1,000	✓			✓	✓
INOVASI ANAK NEGERI OVE-03 OVEN DRYER	6,500,000	50	✓	✓			✓
KIOS MESIN BOX DRYER	15,000,000	150		✓	✓		✓
LIPI MULTIFUNCTION DRYER	Rp 75,000,000	1,000	✓		✓		✓

*Fuel includes LPG and petrol

**Biomass can be in the form of wood cuttings, wood shavings, rice husks, etc.

Given the unmet need in effective dryers for cacao, Kopernik calls for a cross-sectoral effort to develop and test prototypes with a longer term goal to improve the livelihoods of smallholder farmers.

Meeting this need with an effective dryer would bring the following benefits to smallholder farmers:

ECONOMIC IMPACT	Compared to traditional methods, an effective dryer can generate an additional **Rp 207,000 / year** for a typical farmer
OTHER BENEFITS	• **Higher quality** of crop • **Faster** drying time • Greater **control** over drying timing • **Reduced loss** during processing and storing (For more details, please refer to the 'Benefits of Drying' section)

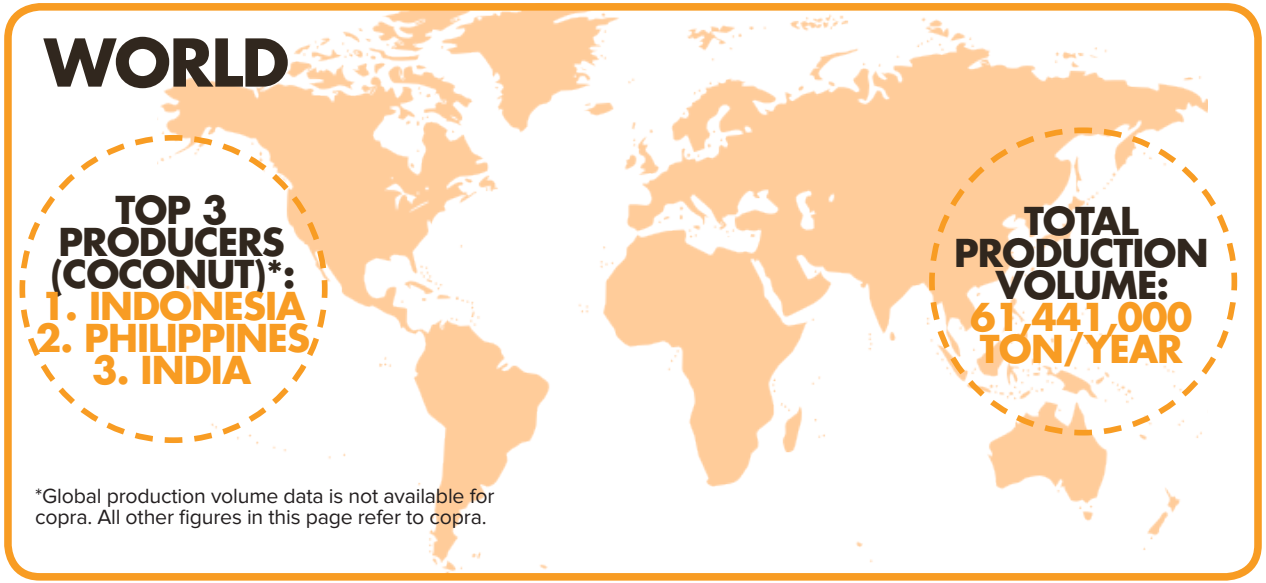
The market size of this unmet need is estimated at:

MARKET OPPORTUNITY	**MARKET SIZE OF DAMAGE DUE TO INEFFECTIVE DRYING (RETAIL PRICE)** **Rp 1.0 TRILLION** **US$ 78 MILLION**

COPRA

There are many unprocessed, semiprocessed, or fully processed coconut products available in international markets. They include virgin coconut oil, cream, milk, powder, cocochemicals, and copra. Copra, the dried kernel of the coconut, is one of the main ingredients in vegetable oil. Research suggests that major post-harvest losses in this commodity are caused by improper drying of the coconut to produce copra.

WORLD

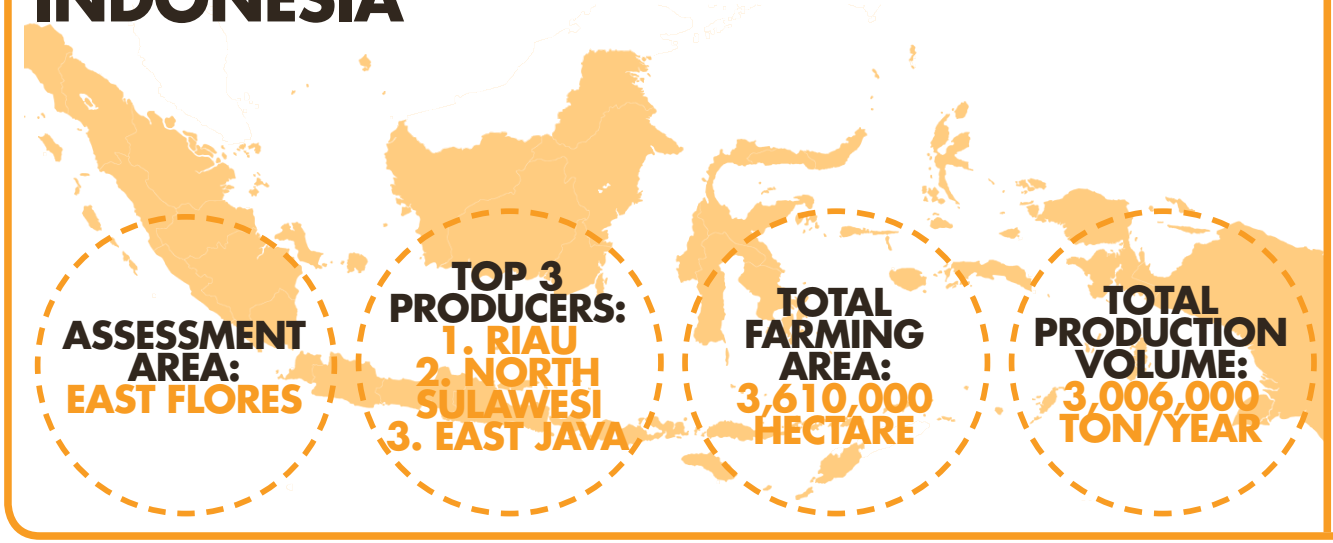


TOP 3 PRODUCERS (COCONUT)*:
1. INDONESIA
2. PHILIPPINES
3. INDIA

TOTAL PRODUCTION VOLUME:
61,441,000 TON/YEAR

*Global production volume data is not available for copra. All other figures in this page refer to copra.

INDONESIA



ASSESSMENT AREA:
EAST FLORES

TOP 3 PRODUCERS:
1. RIAU
2. NORTH SULAWESI
3. EAST JAVA

TOTAL FARMING AREA:
3,610,000 HECTARE

TOTAL PRODUCTION VOLUME:
3,006,000 TON/YEAR

SMALLHOLDER FARMERS

A typical copra farmer in Indonesia:

LAND AREA OF HARVEST
0.24 HA/FARMER

YIELD PER FARMER
273 KG/YEAR

VALUE CHAIN

PRE-HARVEST

SEEDING

12 MONTHS

STEPS:

- The seed from a mature tree (a brown-colored coconut) is kept in a dry place for a month, the upper part is cut and planted.
- Once sprouted, it is moved to a polybag for 6-12 months before transplanting.

GROWING

3-8 YEARS

STEPS:

- The planting area is cleared.
- A seed bed is prepared.
- Fertilizer is applied every month for 3-6 years beginning from 6 month mark after planting.

HARVEST

HARVESTING

1 DAY

STEPS:

- 3-8 years after planting, coconuts are collected manually, once a month, year round.
- They are of a higher quality in dry season.
- Some varieties will continue to produce coconuts for 30 years after the first harvest.

MARKET PRICE: Rp 600/kg	WEIGHT: 100%

CHALLENGES:

- **Extreme weather**, especially drought, will affect the growth of coconut trees.
- **Poor crop management knowledge:** Generally farmers utilize coconut plants that grow naturally. They don't intensively manage the crops, such as maintaining replacement seedlings or following other recommended farming methods. Generally the existing trees are old.

CHALLENGES:

- **Timing:** Harvesting immature nuts may result in rubbery copra with a high moisture content. While harvesting overripe coconuts that have fallen naturally from the tree may produce thinner and lighter copra with low oil content. These coconuts may have already started the germination process, utilizing the stored food in the endosperm.

POST-HARVEST

DRYING

7 DAYS, OR 3 WITH STOVE

STEPS:

- Coconut can be dried using various methods; sun, bed dryer, or in an oven.
- Drying often includes a smoking process using sulphur to prevent fungi, mold, and mildew.
- The moisture level is 50-55% before drying and 5-7% after drying.

MARKET PRICE: Rp 9,500 - 14,000/ kg	WEIGHT: 25%	LOSS: 6%

PROCESSING

VARIES

STEPS:

- Dried copra can be processed into many different commodities, but most of the processing is done at the factory level. Smallholder farmers do not typically process copra into the end product.

STORING

N/A

STEPS:

- Copra is stored using pallets in sacks, ideally avoiding direct contact with the floor to prevent mold.
- Some storage areas are treated with sulphur to be completely sterile from copra fleas, other insects or mildew.

CHALLENGES:

- **Inefficient drying:** The drying process is dependent on weather. When copra has not been exposed to sufficient sun, it becomes moldy. Copra is highly prone to mold. Major post-harvest losses, especially in NTT, are caused by improper drying of copra and poor post-harvest management in general.
- **Lack of knowledge:** There is a knowledge gap on how to process certain coconut products in some areas, such as coconut oil.
- **Contamination during storage:** Copra is prone to losses caused by pests, which may result in up to 15% in losses if stored for more than 6 months.

DRYER NEEDS

As described in the previous page, drying copra involves specific steps and challenges. In particular, the moisture level needs to be reduced from 50-55% to 5-7% without damaging the commodity and with the least amount of effort and cost.

Among the 12 dryers reviewed, the following brands cater to drying copra – either tested or claimed to be applicable by the manufacturer. As the short list demonstrates, only a few commercially available dryers can expedite the drying process effectively. There is a clear need for new prototypes to be developed and more testing to be conducted.

√ main power √ supplementary power √ tested √ not yet tested

DRYER TYPE	PRICE	MAXIMUM CAPACITY (KG)	ENERGY SOURCE				COPRA
			ELECTRICITY	FUEL*	BIOMASS**	SUN	
AGROWINDO BOX IN-4000 INDIRECT DRYER	53,750,000	4,000			√		√
INOVASI ANAK NEGERI OVE-03 OVEN DRYER	6,500,000	50	√	√			√
LIPI MULTIFUNCTION DRYER	75,000,000	1,000	√		√		√

*Fuel includes LPG and petrol

**Biomass can be in the form of wood cuttings, wood shavings, rice husks, etc.

Given the unmet need in effective dryers for copra, Kopernik calls for a cross-sectoral effort to develop and test prototypes with a longer term goal to improve the livelihoods of smallholder farmers.

Meeting this need with an effective dryer would bring the following benefits to smallholder farmers:

ECONOMIC IMPACT	Compared to traditional methods, an effective dryer can generate an additional **Rp 95,000 / year** for a typical farmer
OTHER BENEFITS	• **Higher quality** of crop • **Faster** drying time • Greater **control** over drying timing • **Reduced loss** during processing and storing (For more details, please refer to the 'Benefits of Drying' section)

The market size of this unmet need is estimated at:

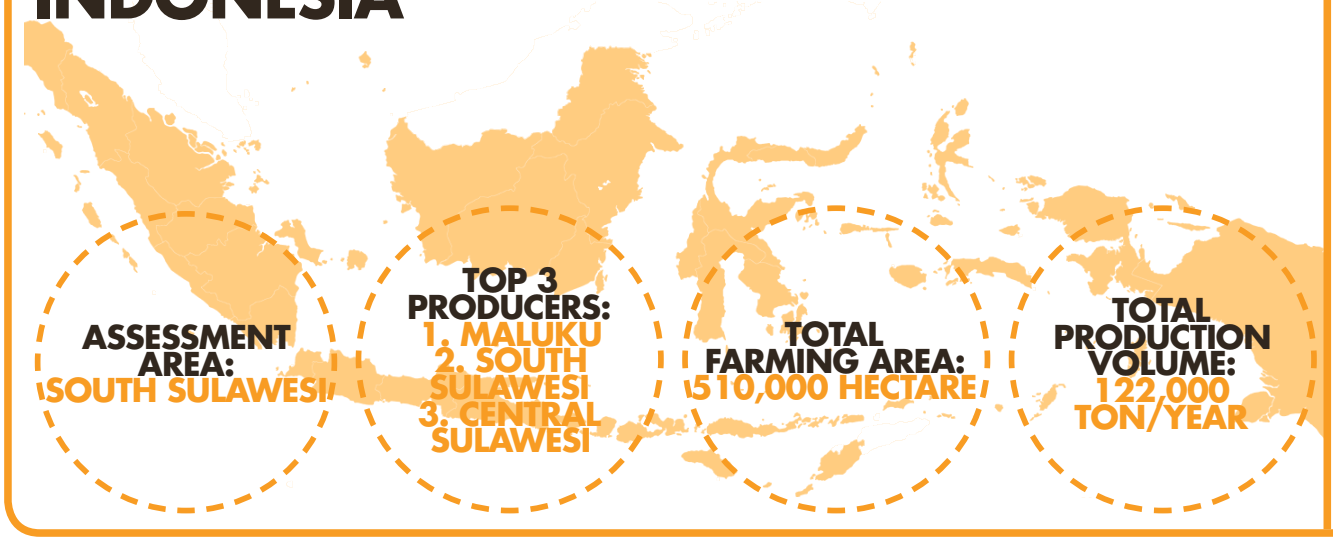
MARKET OPPORTUNITY	**MARKET SIZE OF DAMAGE DUE TO INEFFECTIVE DRYING (RETAIL PRICE)** **Rp 3.8 TRILLION** **US$ 290 MILLION**

CLOVES

Cloves are the immature unopened flower buds of the evergreen tree Eugenia Caryophyllus. A plantation commodity, 97% of cloves are cultivated by smallholder farmers. The majority of the harvested buds are sold dried and mostly unprocessed. Cloves are usually processed into medicine, essential oils, spices, or eugenol.

WORLD

INDONESIA



SMALLHOLDER FARMERS

A typical cloves farmer in Indonesia:

LAND AREA OF HARVEST
0.30 HA/FARMER

YIELD PER FARMER
107 KG/YEAR

VALUE CHAIN

PRE-HARVEST

SEEDING

1-3 YEARS

STEPS:

- Seeds are selected from healthy mature trees (10+ years old).
- The amount of seeds prepared is twice the expected number to be planted.
- Seeds are stored in a humid place for 4-6 days to allow them to sprout.

GROWING

4.5 - 8.5 YEARS

STEPS:

- Seeds are planted in cultivated soil filled with fertilizer, into holes measuring 70x70x70cm.
- Trees are pruned and pesticide is applied to control for pests and diseases.

CHALLENGES:

- **Seed loss:** 50% of seeds cannot be planted due to poor quality.
- **Lenghty preparation:** Farmers prepare the seeds between 1 and 3 years.
- **Soil preparation timing:** Soil preparation must be completed during the beginning or end of the rainy season.

HARVEST

HARVESTING

EVERY 10-14 DAYS FOR 3-4 MONTHS

STEPS:

- The most ripe buds (head of the flower is full but not yet in bloom) are picked.
- The buds are cured by placing them in a bag or crate for 24 hours.
- Only the best quality buds are selected.

MARKET PRICE: Rp 35,000/kg	WEIGHT: 100%

CHALLENGES:

- **Weather:** Extended periods of rain during harvest season slow down the harvesting processes. This can cause the cloves to turn white and become spoiled.

POST-HARVEST

DRYING

1-4 DAYS

STEPS:

- Cloves are dried under the sun until they reach the desired blackish color, with an estimated moisture level of 12-14%.
- The moisture level before drying is 70.3%.
- The dried cloves are cleaned from dirt and stored.

MARKET PRICE:	WEIGHT:	LOSS:
Rp 120,000/kg	67%	3-5%

PROCESSING

N/A

STEPS:

- The buds are stored or sold after the drying process.

STORING

0.5 DAY

STEPS:

- The dried cloves are stored in gunny bags, which are sewn to avoid spillage.

CHALLENGES:

- **Weather:** Unpredicatable weather and prolonged rainy season poses drying challenges for farmers, as it takes longer to reach desired moisture content.
- **Appearance:** Loss of sheen may occur during storage which may impact market price.
- **Storage:** Poor storage conditions could result in loss of oil, mold growth and development of musty flavor and odor. Loss of oil usually occurs due to evaporation which is dependant on moisture content, temperature, and relative humidity during storage. Additionally, long storage periods reduce the quality of the cloves. Farmers may store cloves for too long while they wait to sell them when the price is at its highest. However, storage for more than 6 months may result in a lower quality, because the essential oil and eugenol acetate content is reduced.

DRYER NEEDS

As described in the previous page, drying cloves involves specific steps and challenges. In particular, the moisture level needs to be reduced from 70.3% to 12-14% without damaging the commodity and with the least amount of effort and cost.

For clove drying, there is one technology especially designed for the commodity: the oven dryer by Rumah Mesin. Beyond it, two other dryers should work in theory, but have not been tested yet. There is a clear need for more testing to be conducted and more prototypes to be developed.

✓ main power ✓ supplementary power ✓ tested ✓ not yet tested

DRYER TYPE	PRICE	MAXIMUM CAPACITY (KG)	ENERGY SOURCE				CLOVES
			ELECTRICITY	FUEL*	BIOMASS**	SUN	
GRAINPRO SOLAR BUBBLE DRYER	13,300,000	1,000	✓			✓	✓
INOVASI ANAK NEGERI OVE-03 OVEN DRYER	6,500,000	50	✓	✓			✓
LIPI MULTIFUNCTION DRYER	75,000,000	1,000	✓		✓		✓
RUMAH MESIN CLOVES OVEN DRYER	35,000,000	750		✓	✓		✓

*Fuel includes LPG and petrol

**Biomass can be in the form of wood cuttings, wood shavings, rice husks, etc.

Given the unmet need in effective dryers for cloves, Kopernik calls for a cross-sectoral effort to develop and test prototypes with a longer term goal to improve the livelihoods of smallholder farmers.

Meeting this need with an effective dryer would bring the following benefits to smallholder farmers:

ECONOMIC IMPACT	Compared to traditional methods, an effective dryer can generate an additional **Rp 428,000 / year** for a typical farmer
OTHER BENEFITS	• **Higher quality** of crop • **Faster** drying time • Greater **control** over drying timing • **Reduced loss** during processing and storing (For more details, please refer to the 'Benefits of Drying' section)

The market size of this unmet need is estimated at:

MARKET OPPORTUNITY	**MARKET SIZE OF DAMAGE DUE TO INEFFECTIVE DRYING (RETAIL PRICE)** **Rp 733 BILLION** **US$ 56 MILLION**

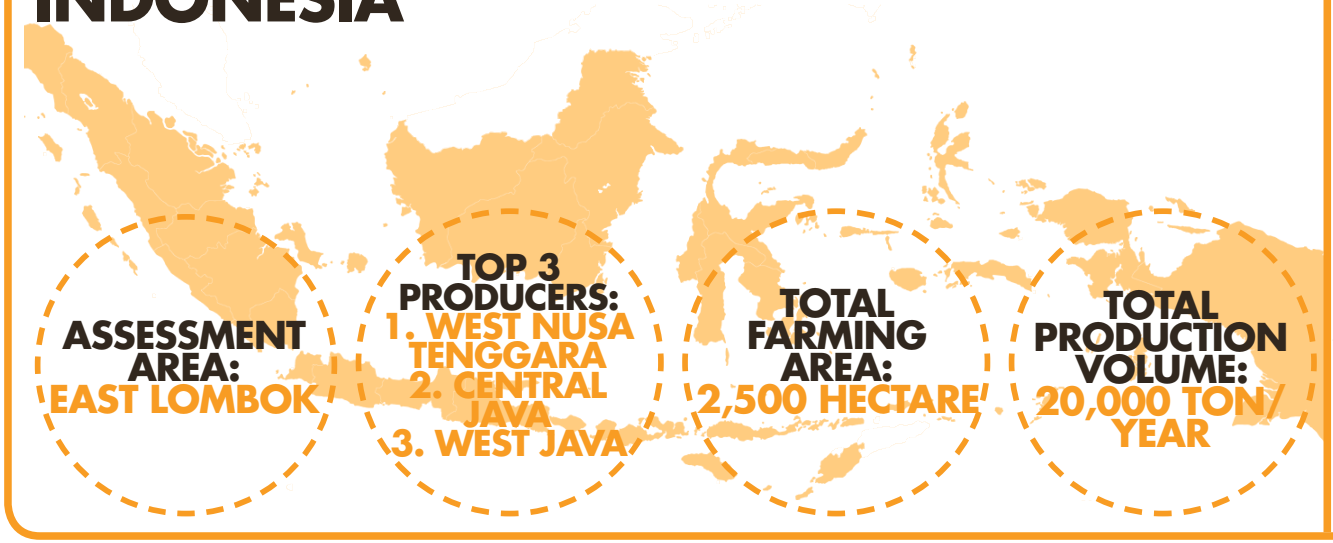
Image source: Leon Brooks, Garlic Cloves, https://goo.gl/pWKBU5

GARLIC

Garlic is a herbaceous plant known for its pungent, edible bulb and its antibiotic properties. In 2013, domestic garlic production was only able to meet less than 5% of the national garlic demand. Shortages are currently resolved through imports. The Indonesian market price for garlic is volatile due to extreme weather variances, low supply in domestic and foreign markets, and distribution challenges.

WORLD

INDONESIA



SMALLHOLDER FARMERS

A typical garlic farmer in Indonesia:

LAND AREA OF HARVEST
0.11 HA/FARMER

YIELD PER FARMER
667 KG/YEAR

VALUE CHAIN

PRE-HARVEST

SEEDING

1-2 WEEKS

STEPS:

- 1kg of seed produces up to 10kg of garlic. Buying seeds is considered expensive.
- Seeding from grown cloves is common. Whole garlic bulbs are separated into cloves and either planted directly or kept in the refrigerator until they sprout.

GROWING

90-120 DAYS

STEPS:

- Land is plowed and after one week, each clove is pushed into the soil at a depth of 2 inches, with the tip pointed up.
- Planted cloves are covered with mulch and watered. Fertilizer is applied.

CHALLENGES:

- **High-risk:** Garlic is a labor-intensive crop and is difficult to grow successfully. Often, Indonesian garlic farmers need to compete with cheaper imported garlic so it is a high-risk option.
- **Lack of knowledge:** Farmers have limited knowledge of seed production, growth cycle, and other factors affecting its growth, yield and quality.

HARVEST

HARVESTING

1-2 DAYS

STEPS:

- Garlic bulbs are harvested when the leaves turn yellow or brown.
- The area around each bulb is loosened with a shovel or by watering.
- The bulbs are pulled out of the ground, usually by hand.

MARKET PRICE:	WEIGHT:
Rp 18,000/kg	100%

CHALLENGES:

- **Soil health:** The quality of the soil degrades over time, escially with heavy inputs of chemical fertilizer, pesticide, and herbicide. This results in decreasing productivity of garlic.

POST-HARVEST

DRYING

14 DAYS

STEPS:

- After harvesting, 15 garlic bulbs and stems are tied together and dried under the sun for 2 weeks.
- The moisture level is on average 65% before drying and 10% after drying.

MARKET PRICE: Rp 30,000/kg	WEIGHT: 95%	LOSS: 3-5%

PROCESSING

1-2 DAYS

STEPS:

- After drying the garlic roots and stalks are removed from the bulbs.
- Garlic is sorted according to grade (usually based on bulb size).

MARKET PRICE: Rp 35,000/kg

STORING

1 YEAR

STEPS:

- For small amounts, the garlic is tied together and hung above the stove; the smoke during cooking helps preserve the garlic.
- For large amounts, the garlic is stored in a moderately humid room (around 70% humidity).
- Dried bulbs can be kept in a ventilated box .

CHALLENGES:

- **Ineffective drying:** When not properly dried, garlic may develop black spots or mold. Farmers sometimes use smoke to dry the garlic, but this may cause the garlic to wrinkle and develop brownish spots, which reduces the quality.
- **Demand:** It is challenging for smaller producers to market this product. The market demands large, unblemished bulbs that are well graded and well packaged. Indonesian garlic producers must compete with cheap garlic imports, so the demand for local garlic drops.

DRYER NEEDS

As described in the previous page, drying garlic involves specific steps and challenges. In particular, the moisture level needs to be reduced from 65% to 10% without damaging the commodity and with the least amount of effort and cost.

Only two available dryers cater to drying garlic, and neither of them has been tested. Even LIPI's multifunctional dryer that should work for most commodities cannot be used for garlic, as the developer believes the garlic bulb would crack and become brownish in that dryer. There is a clear need for more innovation focused on drying garlic.

✓ main power ✓ supplementary power ✓ tested ✓ not yet tested

DRYER TYPE	PRICE	MAXIMUM CAPACITY (KG)	ENERGY SOURCE				GARLIC
			ELECTRICITY	FUEL*	BIOMASS**	SUN	
GRAINPRO SOLAR BUBBLE DRYER	13,300,000	1,000	✓			✓	✓
INOVASI ANAK NEGERI OVE-03 OVEN DRYER	6,500,000	50	✓	✓			✓

*Fuel includes LPG and petrol

**Biomass can be in the form of wood cuttings, wood shavings, rice husks, etc.

Given the unmet need in effective dryers for garlic, Kopernik calls for a cross-sectoral effort to develop and test prototypes with a longer term goal to improve the livelihoods of smallholder farmers.

Meeting this need with an effective dryer would bring the following benefits to smallholder farmers:

ECONOMIC IMPACT	Compared to traditional methods, an effective dryer can generate an additional **Rp 207,000 / year** for a typical farmer
OTHER BENEFITS	• **Higher quality** of crop • **Faster** drying time • Greater **control** over drying timing • **Reduced loss** during processing and storing (For more details, please refer to the 'Benefits of Drying' section)

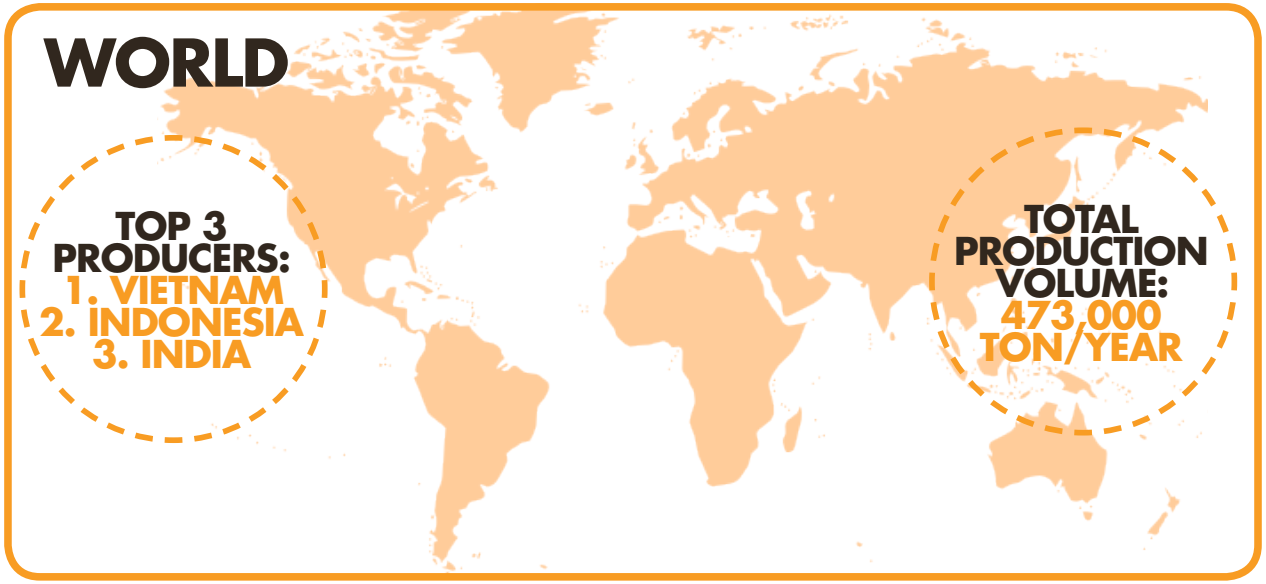
The market size of this unmet need is estimated at:

MARKET OPPORTUNITY	**MARKET SIZE OF DAMAGE DUE TO INEFFECTIVE DRYING (RETAIL PRICE)** **Rp 39 BILLION** **US$ 3.0 MILLION**

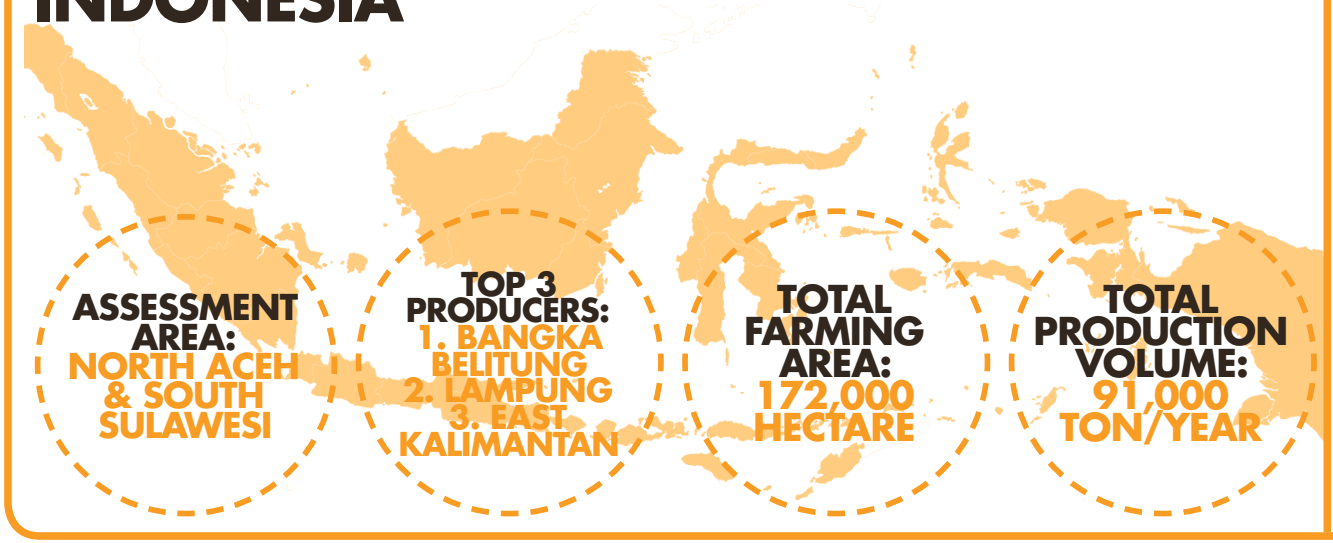
PEPPER

One of Indonesia's top export commodities, pepper, is mostly produced by smallholder farmers across the country. The same plant produces both white and black pepper - it is post-harvest processing that makes these varieties. Indonesia has historically played an important role as a supplier of black and white pepper to the international market.

WORLD



INDONESIA



SMALLHOLDER FARMERS

A typical pepper farmer in Indonesia:

LAND AREA OF HARVEST
0.37 HA/FARMER

YIELD PER FARMER
302 KG/YEAR

VALUE CHAIN

PRE-HARVEST

SEEDING

3-4 MONTHS

STEPS:

- Stems are cut from a healthy pepper plant then soaked in sugar water for 1 hour.
- The stem is placed into a polybag with a planting media.
- Seedlings are kept in the bag for 3-4 months until 5-7 joints appear.

GROWING

2 YEARS

STEPS:

- Land is prepared 40 days prior to planting to reduce soil acidity.
- The stems are planted near a plant that can support the vine's growth. Fertilizer is applied.
- Trimming is done in the 6th, 13th and 21st month of the cycle.

CHALLENGES:

- **Poor seed quality:** Due to limited access to, or poor distribution of high quality seeds, the quality of the crop is poor.
- **High initial investment cost:** Pepper plants will produce fruit after 3 years so it takes time for the farmers' investment to yield a return
- **Limited planting area:** Due to the high initial investment cost, farmers choose to plant other commodities despite the high demand for pepper.
- **Disease:** Crop failure due to disease such as stem rot disease is common.

HARVEST

HARVESTING

ALL YEAR (ONCE/ WEEK)

STEPS:

- *Black Pepper* is harvested after two pepper berries on a stalk turn to yellowish-green (6-7 months after flowering).
- *White Pepper* is harvested when pepper berries are more ripe and turn reddish-yellow in color.

MARKET PRICE: Rp 20,000/kg	WEIGHT: 100%

CHALLENGES:

- **Weather:** Poor or unpredictable weather patterns affect the growing, transplanting, and drying process of pepper. Heavy rains lead to disease and attract pests.

POST-HARVEST

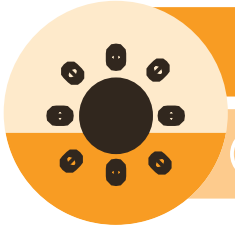
PROCESSING

10 DAYS

STEPS:

- The fruit is separated from the stalk and sorted using 4mm mesh to remove small, unripe pepper
- *Black pepper* is soaked for 1-2 minutes in 80°C water.
- *White pepper* is soaked in water for 7-10 days and then peeled by hand.

DRYING



3 - 7 DAYS

STEPS:

- Black or white pepper is spread on a mat or plastic sheet for 3-7 days to be dried under the sun.
- The moisture level is on average 77% before drying and 11-12% after drying.

MARKET PRICE: Rp 120,000/kg	WEIGHT: 39%	LOSS: 3-5%

STORING

3 MONTHS

STEPS:

- Both black and white peppercorns can be stored in any clean sack or plastic container. These should not directly touch the ground and should be placed in a dry storage location.

CHALLENGES:

- **Labor intensity:** Considerable labor is required to peel the tremendous amounts of pepper for white pepper processing.
- **Price fluctuation:** Volatility in price for both fresh and dired peppercorns leads farmers to switch to growing other commodities.
- **Temperature sensitivity:** Drying temperature should exceed 60°C to avoid loss of quality.

DRYER NEEDS

As described in the previous page, drying pepper involves specific steps and challenges. In particular, the moisture level needs to be reduced from 77% to 11-12% without damaging the commodity and with the least amount of effort and cost.

Very few available dryers cater to pepper, and none of them has been tested. There is a clear need for more testing to be conducted and more prototypes to be developed especially for such a delicate spice commodity.

✓ main power ✓ supplementary power ✓ tested ✓ not yet tested

DRYER TYPE	PRICE (Rp)	MAXIMUM CAPACITY (KG)	ENERGY SOURCE				PEPPER
			ELECTRICITY	FUEL*	BIOMASS**	SUN	
GRAINPRO SOLAR BUBBLE DRYER	13,300,000	1,000	✓			✓	✓
INOVASI ANAK NEGERI OVE-03 OVEN DRYER	6,500,000	50	✓	✓			✓
LIPI MULTIFUNCTION DRYER	75,000,000	1,000	✓		✓		✓

*Fuel includes LPG and petrol

**Biomass can be in the form of wood cuttings, wood shavings, rice husks, etc.

Given the unmet need in effective dryers for pepper, Kopernik calls for a cross-sectoral effort to develop and test prototypes with a longer term goal to improve the livelihoods of smallholder farmers.

Meeting this need with an effective dryer would bring the following benefits to smallholder farmers:

ECONOMIC IMPACT	Compared to traditional methods, an effective dryer can generate an additional **Rp 708,000 / year** for a typical farmer
OTHER BENEFITS	• **Higher quality** of crop • **Faster** drying time • Greater **control** over drying timing • **Reduced loss** during processing and storing (For more details, please refer to the 'Benefits of Drying' section)

The market size of this unmet need is estimated at:

MARKET OPPORTUNITY	**MARKET SIZE OF DAMAGE DUE TO INEFFECTIVE DRYING (RETAIL PRICE)** **Rp 655 BILLION** **US$ 50 MILLION**

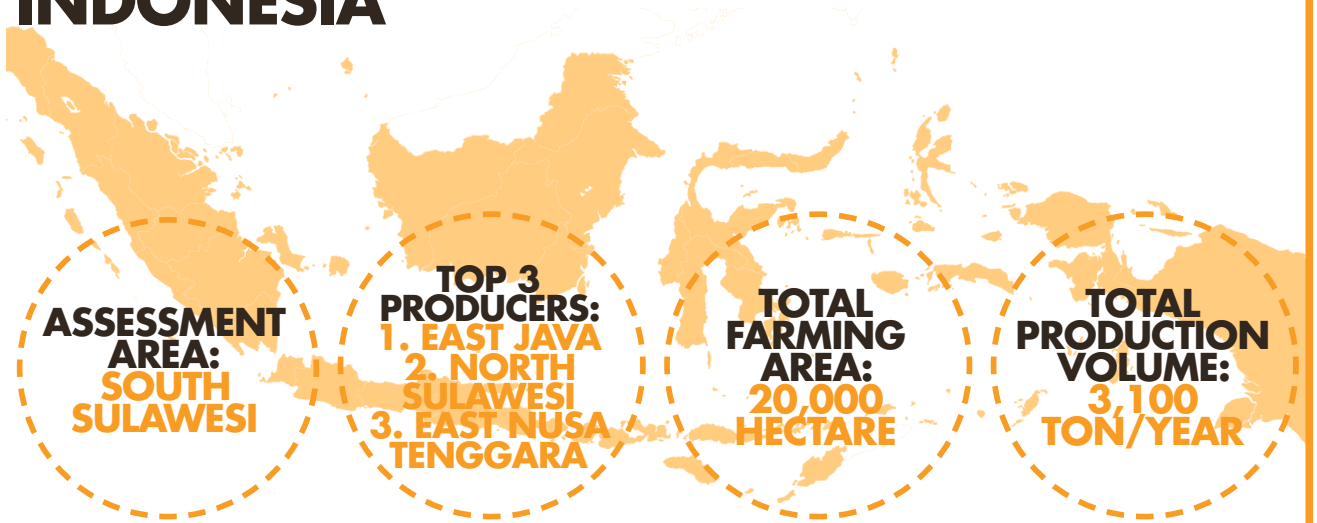
Image source: Alphaomega1010, Vanille Bourbon de Madagascar, https://goo.gl/7OBhqm

VANILLA

Vanilla is the world's second most expensive spice because growing vanilla seed pods is labor-intensive and complex. The plant even needs help during pollination. Despite the expense, vanilla is highly valued for its flavor. Vanilla is widely used in both commercial and domestic baking, perfume manufacture, and aromatherapy. Indonesia is the largest producer of vanilla in the world.

WORLD

INDONESIA



SMALLHOLDER FARMERS

A typical vanilla farmer in Indonesia:

LAND AREA OF HARVEST
0.10 HA/FARMER

YIELD PER FARMER
38 KG/YEAR

KOPERNIK

VALUE CHAIN

PRE-HARVEST

SEEDING

7-8 MONTHS

STEPS:

- The branch of a mature plant is cut and planted in a growing media of rocks, sand, sawdust and coconut shell shavings.
- After 2 months, it is moved to a polybag with dirt and manure for 5-6 months.

GROWING

1.5-3 YEARS

STEPS:

- 3-4 plants are planted near trailing to support the vine.
- They are trimmed as necessary to avoid disease and increase number of branches.
- Pollination is done by the farmer using a thin stick, lifting the labellum and introducing the pollen to the pistil.

CHALLENGES:

- **Seed availability:** Seed is not always available, depending on market demand and the price for vanilla.
- **Labor intensity:** Vanilla has complex and time-consuming care and seeding techniques, such as choosing the right supporting plant, proper vegetative propagation and sunlight intensity.
- **Pollination timing:** Farmers must pollinate vanilla at a very specific time (7am-10am). The blooming time is only once per year (August to October) and, if missed, the harvest will be lost.

HARVEST

HARVESTING

7-9 MONTHS

STEPS:

- Vanilla pods are prime for harvest 8-9 months after a successful pollination.
- Each stem should produce between 8-15 quality vanilla pods.
- Only the ripe pods are selected, carefully and by hand

MARKET PRICE:	WEIGHT:
Rp 25,000/kg	100%

CHALLENGES:

- **Disease outbreak:** Root and stem rot (RSR, or Busuk Batang Vanili) outbreak lead to lower production and quality of vanilla. It can cause the plant to die, which can result in up to 80% loss. Some farmers have even reported a 100% loss.

POST-HARVEST

DRYING

1 WEEK & 3-6 WEEKS

STEPS:

- To cure, pods are soaked, boiled, and placed in box for 24-48 hours.
- Pods are dried on shelves for 2.5 hours. The moisture level before drying is 60-70%. Pods are then dried for 30-45 days inside (10 days with oven) to result in a moisture level of 25-30%.

MARKET PRICE:	WEIGHT:	LOSS:
Rp 300,000/kg*	25%	3-5%

*While Rp. 300,000/kg is the retail price in South Sulawesi where the research team visited, we are aware that the global prices are as high as $400/kg given supply shortage and price speculation.

PROCESSING

N/A

STEPS:

- The pods are stored or sold after the drying process.

STORING

2-3 MONTHS

STEPS:

- Conditioning: Pods are tied in bunches of 50-100 pods and stored in a box, covered with oil paper in a dry and cool room for 2-3 months.

CHALLENGES:

- **Ineffective drying:** Vanilla usually goes through a wilting treatment or curing process, which includes boiling, after which it needs to be dried as soon as possible to avoid mold. The current drying processes take up to 7 weeks. Farmers also face challenges finding spaces that provide indirect sunlight, especially during the second phase of drying.
- **Weather:** The manual drying process is very dependent on the weather. Ovens are used by some farmers to dry vanilla, however this relies on LPG which is costly to purchase.

DRYER NEEDS

As described in the previous page, drying vanilla involves specific steps and challenges. In particular, the moisture level needs to be reduced from 60-70% to 25-30% without damaging the commodity and with the least amount of effort and cost.

Very few available dryers cater to vanilla, and none of them has been tested. There is a clear need for more testing to be conducted and more prototypes to be developed especially for such a delicate spice commodity.

√ main power √ supplementary power √ tested √ not yet tested

DRYER TYPE	PRICE (Rp)	MAXIMUM CAPACITY (KG)	ENERGY SOURCE				VANILLA
			ELECTRICITY	FUEL*	BIOMASS**	SUN	
GRAINPRO SOLAR BUBBLE DRYER	13,300,000	1,000	√			√	√
INOVASI ANAK NEGERI OVE-03 OVEN DRYER	6,500,000	50	√	√			√
LIPI MULTIFUNCTION DRYER	75,000,000	1,000	√		√		√

*Fuel includes LPG and petrol

**Biomass can be in the form of wood cuttings, wood shavings, rice husks, etc.

OPPORTUNITIES & BENEFITS

Given the unmet need in effective dryers for vanilla, Kopernik calls for a cross-sectoral effort to develop and test prototypes with a longer term goal to improve the livelihoods of smallholder farmers.

Meeting this need with an effective dryer would bring the following benefits to smallholder farmers:

ECONOMIC IMPACT	Compared to traditional methods, an effective dryer can generate an additional **Rp 142,000 / year** for a typical farmer
OTHER BENEFITS	• **Higher quality** of crop • **Faster** drying time • Greater **control** over drying timing • **Reduced loss** during processing and storing (For more details, please refer to the 'Benefits of Drying' section)

The market size of this unmet need is estimated at:

MARKET OPPORTUNITY	**MARKET SIZE OF DAMAGE DUE TO INEFFECTIVE DRYING (RETAIL PRICE)** **Rp 46 BILLION** **US$ 3.5 MILLION**

ECONOMIC BENEFITS OF EFFICIENT DRYING

Economic benefits for farmers refer to the additional income farmers could earn from drying their commodities in an efficient manner, as compared to drying using the current inefficient methods that result in approximately 5% in losses.

The figures are calculated using the market price of each commodity in its undried form, natural weight loss proportion through drying, and estimated damage percentage for each commodity. To calculate annual benefits, the economic benefit per kilogram is multiplied by the annual yield for a typical farmer of the commodity studied.

MARKET OPPORTUNITIES

We define market opportunity as the estimated market loss due to inefficient drying processes. The market loss is calculated based on national production volume per year, estimated damage percentage in inefficient drying process, and retail price, using an exchange rate of 1 USD = Rp. 13,082 (as per 7 November 2016).

As the retail price highly depends on buyers and geography, we mainly rely on data at the national level, namely the Ministry of Trade's *Sistem Pemantauan Pasar Kebutuhan Pokok (SP2KP), Info Pangan Nasional from Bank Indonesia, Direktorat Jenderal Perkebunan*, and *Badan Pusat Statistik*. For certain commodities, other data sources are also used. These include farmer interviews for sorghum and cloves, international standard prices from the International Cocoa Organization for cacao, and the World Bank for copra and coffee.

Figure 4: **Retail Price per kg (Rp)**

RETAIL PRICE PER KG	
Rice	Rp 11,000
Maize	Rp 7,000
Sorghum	Rp 6,000
Cacao	Rp 35,000
Coffee	Rp 44,000
Copra	Rp 13,000
Cloves	Rp 120,000
Pepper	Rp 144,000
Garlic	Rp 39,000
Vanilla*	Rp 300,000

*While Rp. 300,000/kg is the retail price in South Sulawesi where the research team visited, we are aware that the global prices are as high as $400/kg given supply shortage and price speculation.

MAIZE

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