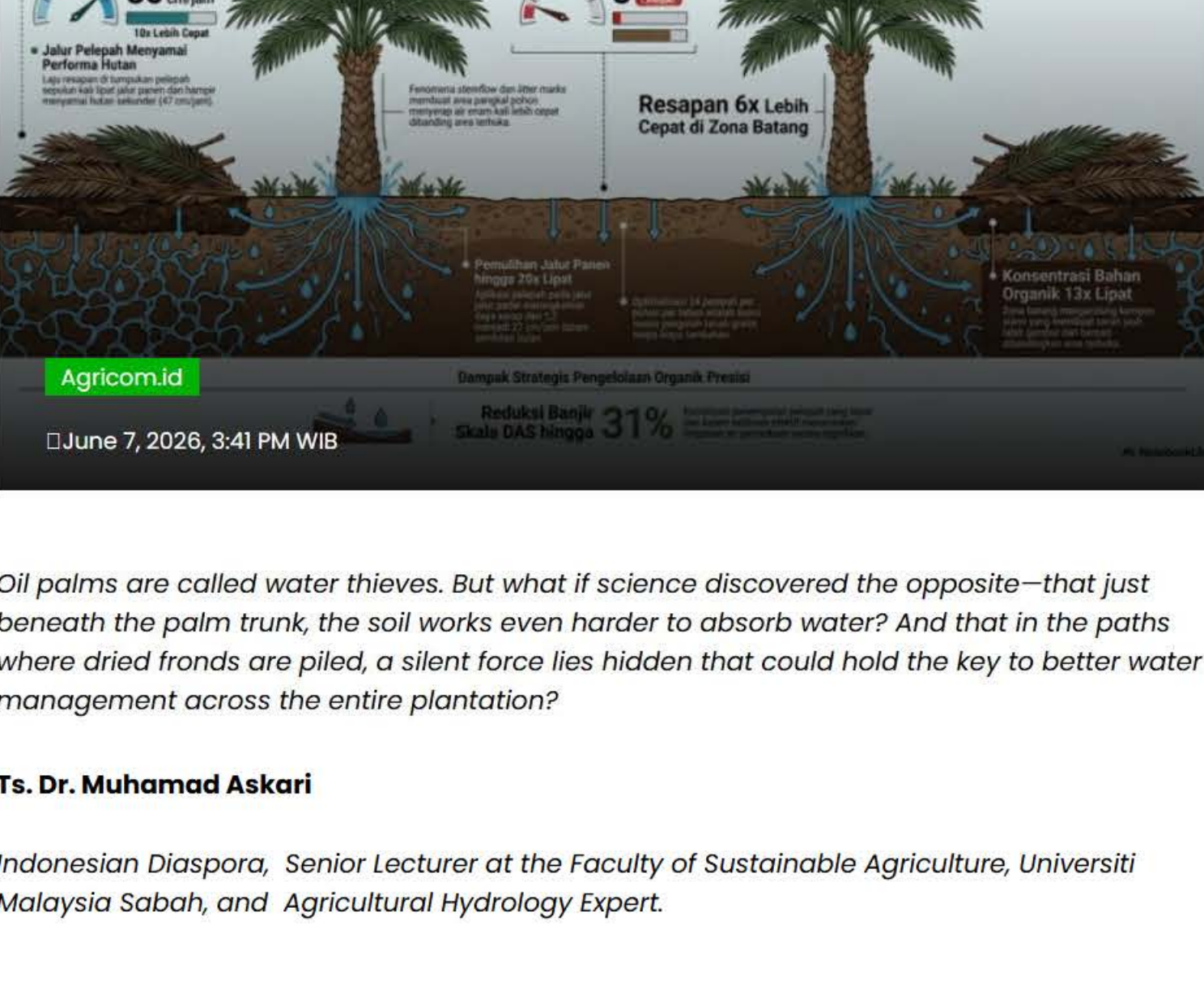
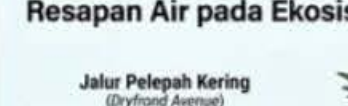


Under Oil Palm Trunks, Water Seeps In 6 Times Faster

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Oil palms are called water thieves. But what if science discovered the opposite—that just beneath the palm trunk, the soil works even harder to absorb water? And that in the paths where dried fronds are piled, a silent force lies hidden that could hold the key to better water management across the entire plantation?

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AGRICOM, JAKARTA – Oil palms have already acquired a reputation as “water thieves.” Their name is invoked every time a river runs dry, every time a community’s well has to be dug deeper, every time the dry season feels longer than in previous years. But what if science discovered the opposite—that just beneath the oil palm trunks, the soil works far harder to absorb water than anywhere else around it? And that along the paths where the dried fronds are piled, a quiet force lies hidden that could be the key to better water management across the entire plantation?

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Dark Circles That Are Not a Disease

Have you ever noticed the dark rings at the base of the trunks of mature oil palms in plantations? They’re a deeper color than the surrounding soil, softer in texture, and seem to wrap around the trunk like a thin scarf wrapped around the soil. Many people think they’re signs of disease, or signs of spilled fertilizer. But researchers have another name for them: litter marks—think of them as a “natural organic carpet” formed from dried fronds, leaf litter, and other organic debris that have fallen and decayed over the years right around the trunk.

An international research team led by the author, then a lecturer at Universiti Teknologi Malaysia Johor Bahru, and scientists from Japan, the United States, and Brazil, decided to investigate this often-overlooked loop. The author and his doctoral students went down to an 18-year-old oil palm plantation in Johor, Malaysia, carrying a special infiltration meter—a 20-centimeter-diameter disc placed on the ground and filled with water in a controlled manner, much like a doctor testing how quickly a patient’s body absorbs IV fluids through a tube. The device, called a tension disc infiltrometer, measures one thing with great precision: how quickly water actually seeps into the soil below.

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The results of the measurements were published in the journal *Geoderma*—one of the world’s leading soil science journals. And the numbers contained therein made the researchers smile a little. The rate of water infiltration into the soil in the oil palm trunk zone was six times higher than in the open area between two trees. Not twice. Not three times. Six times.

“The rate of water infiltration in the oil palm trunk zone is six times higher than the soil in the open area between the trees.”

Two Fates from the Same Raindrop

To understand why this figure occurs, imagine a simple scene: a heavy rain has just fallen over a palm oil plantation. Millions of drops of water fall simultaneously from the sky—but their fates are not the same, simply because they land in different places.

Some raindrops land on the palm fronds, which stretch out like giant umbrellas. The water doesn’t fall directly to the ground. It flows slowly along the curve of the frond, along the base of the stem, and then drips gently around the tree trunk—much like rainwater flowing along the edge of a zinc roof and trickling quietly at the end. This process is what scientists call stemflow, or literally “stem flow.” And it’s at this landing point, right on top of the dark organic carpet we often overlook, that the soil welcomes the water with open arms.

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Why is the soil there so hospitable and “thirsty” for water? Because it has been naturally prepared for 18 years. Its organic matter content—think of it as “natural compost” that keeps the soil loose and alive—is 13 times higher than the soil in the open area between two trees. Its porosity, the amount of empty space between soil particles where water can penetrate and be retained, is up to 10 percent higher. It’s the same difference as pouring water onto a newly purchased dish sponge—soft, porous, and instantly absorbent—versus pouring water onto painted brick: one absorbs, the other repels.

Meanwhile, raindrops falling in the open space between two tree trunks meet a completely different fate. This is where fruit trucks pass twice a month, their wheels leaving pressure that gradually compacts the soil like dough under constant pressure and crushing. The organic matter content here ranges from just 0.086 to 0.134 percent—a mere fraction of the 0.290 to 1.159 percent in the trunk zone. As a result, the compacted soil behaves like a paved road surface repelling rain: instead of soaking down, the water flows rapidly across the surface, eroding the topsoil and carrying the mud away into the drainage ditches.

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Three Faces of the Land We Never Noticed

Until now, most of us have imagined the soil within a single oil palm plantation as uniform. One soil type, one character, one destiny. It’s like thinking all the pages in a book are the same color. Yet science reveals a far more colorful and dramatic picture than that.

Within the same expanse of oil palm plantation, there are three soil zones with very different personalities — and all three are defined not by natural heritage, but entirely by how humans treat the land every day.

The first is the soil beneath the tree trunks: the stemflow zone with six times faster infiltration and the richest organic carpet, silently created over years without anyone intentionally building it. The second is the harvest strip—the soil continues to compact and becomes less receptive to water each season. And the third is the zone least discussed, yet it holds enormous potential: the frond strip, or what is often called the frond avenue in the field—a strip where dried fronds from routine pruning are stacked in an orderly fashion between rows of trees.

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A “Trash Dump” That Almost Looks Like a Forest

A group of researchers from the Bogor Agricultural University, in collaboration with a team from the University of Göttingen in Germany, decided to directly measure what was actually happening in the soil beneath the piles of palm fronds. They went into the field in Jambi Province, Sumatra—one of the fastest-growing areas of oil palm plantations in Indonesia—and measured infiltration using a double-ring infiltrometer, which works like two stacked tin rings stuck into the ground: water is poured into one, and then the researchers measure how quickly it disappears into the subsoil.

What they found, and later published in the international journal *Sustainability of Water Quality and Ecology*, was a sequence that immediately challenged many of our long-held assumptions. The soil in open cropland was only absorbing water at a rate of 3 centimeters per hour—almost like pouring water over dry clay. Rubber plantations were slightly better at 7.8 centimeters per hour. Then suddenly there was a huge jump: piles of oil palm fronds reached 30 centimeters per hour. And undisturbed secondary forest topped the ladder at 47 centimeters per hour.

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This means the soil beneath the piles of dried fronds absorbs water 10 times faster than the soil of regular oil palms in open harvesting strips. The gap between the frond piles’ capacity and that of secondary forest is only 17 centimeters per hour—a difference that, in the world of hydrology, the study of water movement in nature and within the soil, is very small. The strip we once considered nothing more than an “organic waste dump” turns out to be the second most productive water catchment zone in the entire plantation.

The secret is exactly the same as the secret in the trunk zone: organic matter. The fronds piled up in the strip slowly decompose, breaking down into organic compounds that loosen the soil, open up tiny spaces between the soil particles, and invite earthworms and millions of invisible microorganisms that work like micro-tunnel diggers in the soil. Each tiny tunnel is a quick pathway for rainwater to seep deep beneath—rather than racing along the surface and being wasted away in drainage ditches.

“The leaf-frond strip, often considered merely an “organic waste dump,” actually absorbs water 10 times faster than an open harvest strip — almost matching the capacity of secondary forests.”

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An Experiment That Turned a Harvest Path into a Resorption Path

This surprising finding from Jambi provokes a bolder and more practical question: if fronds are proven to be able to turn “organic waste bins” into catchment zones that are almost the same as forests, what would happen if the fronds were also spread across already very dense and hard-packed harvest paths?

This question was answered directly through research conducted at Universiti Putra Malaysia. For nine months, researchers observed two adjacent harvesting lines: one left as is without any treatment, and the other routinely exposed to a minimum amount of palm fronds, about 9.2 kilograms per tree per year.

The results were consistent and undeniable. The unplanted path remained firm, solid, like a road that never rested. But the path covered with the palm fronds began to slowly change, like the soil being given a chance to breathe and recover. The rate at which water seeped into the soil, which had initially ranged from 1.2 to 7.2 centimeters per hour, jumped to between 14.70 and 27.00 centimeters per hour after nine months. That was a fourfold to more than twentyfold increase—from soil that nearly repelled water to soil that eagerly absorbed it. Imagine if your car, previously stuck in a traffic jam at an intersection, were suddenly able to drive freely on the highway—such was the change experienced by every drop of water that tried to seep into the soil.

The decaying fronds consistently increased the soil organic matter content in the 0 to 15 centimeters layer—the most important “life zone” for plant roots—by 0.32 to 0.83 percent. And as that organic matter increased, the soil’s water-holding capacity also measurably increased. Soil that previously behaved like a leaky container now began to behave like a sponge, absorbing and retaining: taking in water during heavy rains, then slowly releasing it to the palm roots during the dry season when it was most needed.

Three Numbers That Speak Louder Than a Thousand Arguments

When we put these three major findings side by side, the picture becomes very clear and very difficult to dispute. In the tree trunk zone, the soil’s saturation water conductivity—the maximum rate at which water infiltrates when the soil is completely saturated—reaches 0.1605 to 0.1738 centimeters per minute, six times higher than in the open inter-tree zone. In the frond-bed zone, the water infiltration rate reaches 30 centimeters per hour, ten times higher than the 3 centimeters per hour in the open harvest strip. And harvest strips treated with frond beds for nine months can increase their infiltration rate to 27 centimeters per hour.

Three figures, from three different studies, in three different locations—but they all point to the same conclusion. The key is organic matter. Not expensive chemical fertilizers, not drainage engineering requiring heavy equipment, not futuristic technological interventions. But rather the material the orchards themselves produce for free every day—about 24 fronds per tree per year—and which has too often been underutilized.

What Does All This Mean for the River Downstream?

The team from the Bogor Agricultural University and the University of Göttingen didn’t stop at infiltration figures in the field. They went further by simulating the impact on a much larger scale using the SWAT model—an internationally recognized hydrological simulation software that works like a “virtual garden” inside a computer where scientists can test “what ifs” without having to wait decades in the field.

The results speak directly to our collective interests. Actively and consistently managing leaf stalk piles throughout the plantation can reduce total surface runoff—rainwater that doesn’t soak into the soil and rushes over it, carrying mud, and overflowing into neighboring rice fields—by 10 percent at the watershed scale. A 10 percent reduction in peak flooding can mean the difference between a flooded rice field and one that survives, between a bridge that survives and one that is washed away. And when combined with the construction of simple sediment retention ponds—as few as 20 per hectare, without any sophisticated technology—that runoff reduction can reach 31 percent. Thirty-one percent more water infiltrates quietly into the soil and replenishes water reserves for the dry season.

What makes all this even more valuable is one simple fact: the ingredients are already in the garden. The cost is virtually zero. All that needs to be changed is habits.

“By simply changing the placement of the fronds, flood runoff at the watershed scale can be reduced by up to 31 percent. Without additional costs. Without new technology.”

More Accurate Questions for Every Garden Owner

A single oil palm plantation, it turns out, is not a single, uniform expanse of land. It is a mosaic of three faces of soil that coexist without our awareness: the tree trunk zone that silently works six times harder to absorb water, the frond strip that has unwittingly become the second-best hydrological barrier in the entire plantation, and the harvest strip that slowly and inexorably moves toward hard, impermeable soil if not properly maintained.

hydrological barrier in the entire plantation, and the harvest strip that slowly and inexorably moves toward hard, impermeable soil if not properly maintained.

These three faces are not a destiny written by nature and cannot be changed. They are the result of small choices made every day in the field: where the fronds are placed after they are cut, whether the harvest lanes are occasionally given a break from vehicle traffic, whether there are enough hands patient enough to spread the harvested fronds on the hardened lanes. When fronds are removed from the orchard to be sold to other industries, or left to pile up in just one corner of the orchard instead of being spread evenly along the lanes where they are needed most, the orchard is slowly losing its single most reliable soil-working machine—a machine that works for free, without electricity, without an operator, twenty-four hours a day, seven days a week, all year round.

So the real question every plantation owner needs to answer—whether a smallholder with two hectares on the outskirts of Jambi or an estate manager with tens of thousands of hectares in Kalimantan— isn’t “Are my palms water-hungry?” The more appropriate question, and the far more useful answer, is this: what percentage of my land is behaving like a healthy frond strip, and what percentage is behaving like a hard-to-reach harvest strip? The answer doesn’t require complex calculus. Simply walk through the plantation after a heavy rain and honestly note where water lingers and where it drains quickly. That’s enough to determine whether the plantation will still be fertile and productive twenty years from now—and whether the river downstream will still flow smoothly for the children and grandchildren who will inherit it.

Scientific Notes

*This article draws on findings published in the journal *Geoderma* (Abd Rashid et al., 2015); the journal *Sustainability of Water Quality and Ecology* (Tarigan et al., 2016); and research by Universiti Putra Malaysia on oil palm frond management and the physical condition of plantation soil (Mohd Ali Aman, 1997).*