INOVASI GLOBAL

Ensiklopedia Teknologi Pertanian untuk Masa Depan Pangan

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(i) Setiap Orang yang dengan tanpa hak melakukan pelanggaran hak ekonomi sebagaimana dimaksud dalam Pasal 9 ayat (1) huruf i untuk Penggunaan Secara Komersial dipidana dengan pidana penjara paling lama 1 (satu) tahun dan/atau pidana denda paling banyak Rp 100.000.000 (seratus juta rupiah).

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KATA PENGANTAR

Pertanian merupakan salah satu sektor fundamental yang menopang kehidupan manusia di seluruh dunia. Di tengah tantangan global seperti perubahan iklim, pertumbuhan populasi yang pesat, dan keterbatasan sumber daya alam, inovasi teknologi pertanian menjadi kunci utama untuk mewujudkan ketahanan pangan yang berkelanjutan. Buku "Inovasi Global: Ensiklopedia Teknologi Pertanian untuk Masa Depan Pangan" hadir sebagai jawaban atas kebutuhan akan pemahaman menyeluruh mengenai berbagai teknologi canggih yang tengah mengubah wajah pertanian dunia.

Visi dari buku ini adalah menjadi sumber referensi terpercaya yang mengintegrasikan pengetahuan dan inovasi teknologi pertanian dari berbagai belahan dunia, yang dapat digunakan oleh akademisi, praktisi, pembuat kebijakan, dan masyarakat luas. Tujuan utama buku ini adalah memberikan gambaran komprehensif dan sistematis mengenai kemajuan teknologi pertanian yang meliputi bioteknologi, otomasi, pertanian presisi,

urban farming, serta teknologi energi terbarukan, yang semuanya berperan penting dalam meningkatkan produktivitas dan keberlanjutan sistem pangan global.

Kami menyadari bahwa pencapaian buku ini bukanlah hasil kerja individu, melainkan buah dari kolaborasi berbagai pihak. Oleh karena itu, kami menyampaikan penghargaan setinggi-tingginya kepada para ahli, peneliti, dan kontributor yang telah memberikan wawasan mendalam serta data akurat untuk menyusun buku ini. Ucapan terima kasih juga kami haturkan kepada penerbit, editor, dan semua pihak yang mendukung proses penerbitan sehingga buku ini dapat terselesaikan dengan baik.

Semoga buku ini dapat menjadi sumber inspirasi dan pedoman dalam menghadapi tantangan pertanian masa depan, sekaligus mendorong lahirnya inovasi-inovasi baru demi keberlanjutan pangan dunia.

Surabaya, Mei 2025
Penulis

Yudianto S.S.T., M.T.

DAFTAR ISI

GLOSARIUM

ISTILAH	PENJELASAN
Agrikultur Presisi /Pertanian Presisi	Teknologi yang menggunakan sensor, GPS, dan data analitik untuk meningkatkan efisiensi dan hasil pertanian.
Bioteknologi Pertanian	Penggunaan teknik biologi modern seperti rekayasa genetika untuk meningkatkan tanaman dan hewan ternak.
Rekayasa Genetika (Genetic Engineering)	Modifikasi langsung gen dalam organisme untuk menghasilkan sifat yang diinginkan.
Transgenik	Organisme yang telah dimodifikasi genetiknya dengan gen dari spesies lain.
Genetically Modified Organisms (GMOs)	Organisme yang telah dimodifikasi secara genetik untuk menghasilkan sifat yang diinginkan, seperti ketahanan terhadap hama atau toleransi terhadap kondisi lingkungan ekstrem.

CRISPR	(Clustered Regularly Interspaced Short Palindromic Repeats) adalah teknologi penyuntingan gen yang memungkinkan ilmuwan untuk mengubah DNA organisme secara presisi. CRISPR digunakan sebagai "gunting molekuler" untuk **memotong, menghapus, atau mengganti** bagian tertentu dari materi genetic. **Komponen utama** CRISPR adalah enzim **Cas9** (CRISPR-associated protein 9), yang dipandu oleh molekul RNA (guide RNA) ke lokasi spesifik dalam DNA.
Mikroorganisme	Seperti bakteri, jamur, dan cyanobacteria digunakan dalam pertanian sebagai **biofertilizer**, yaitu pupuk alami yang meningkatkan ketersediaan unsur hara bagi tanaman. Jenis umum biofertilizer: Rhizobium, Azospirillum dan Azotobacter, Mycorrhizae, Phosphate-Solubilizing Bacteria (PSB). Manfaat ilmiah: Meningkatkan kesuburan tanah, mengurangi ketergantungan pada pupuk kimia, dan mendukung pertanian berkelanjutan.
Keamanan hayati (biosafety)	Merujuk pada prinsip, kebijakan, dan prosedur ilmiah yang dirancang untuk mengelola risiko yang terkait dengan penggunaan organisme hasil rekayasa genetika (GMO) atau mikroorganisme

	yang dimodifikasi secara bioteknologi. Tujuan utama adalah Mencegah dampak negatif terhadap kesehatan manusia, hewan, dan lingkungan, Menyusun regulasi untuk pengujian, pelepasan, dan pemantauan organisme hasil bioteknologi.
Regulasi bioteknologi	Mengacu pada kerangka hukum dan kebijakan yang mengatur: Penelitian dan pengembangan produk bioteknologi, Uji coba lapangan (field trial), Persetujuan pemasaran produk GMO atau hasil penyuntingan gen, Pelabelan produk transgenik untuk konsumen. Contoh regulasi: Protokol Cartagena (bagian dari Konvensi PBB tentang Keanekaragaman Hayati) adalah perjanjian internasional untuk memastikan keamanan transfer, penanganan, dan penggunaan organisme hasil rekayasa genetik.
Biostimulants	Produk yang meningkatkan pertumbuhan dan kesehatan tanaman melalui proses alami, seperti mikroorganisme atau ekstrak tumbuhan.
Livestock Genetics	Studi dan manipulasi genetika hewan ternak untuk meningkatkan performa dan kesehatan hewan.
IoT Pertanian (Internet of Things)	Penggunaan perangkat digital yang saling terhubung (sensor, drone, dll.)

	untuk mengumpulkan dan menganalisis data pertanian.
Sistem Informasi Geografis (SIG/GIS)	Teknologi untuk memetakan dan menganalisis data spasial pertanian, seperti kelembaban tanah dan topografi lahan.
Drone Pertanian	Pesawat nirawak yang digunakan untuk pemetaan lahan, penyemprotan pestisida, dan pemantauan tanaman.
Pertanian Vertikal (vertical farming)	Sistem pertanian yang dilakukan dalam struktur bertingkat, seringkali dalam lingkungan terkontrol.
Hidroponik	Teknik budidaya tanaman tanpa tanah, menggunakan larutan nutrisi mineral.
Aeroponik	Budidaya tanaman dengan akar digantung di udara dan disemprot larutan nutrisi.
Aquaponics	Sistem produksi pangan yang menggabungkan akuakultur (budidaya ikan) dengan hidroponik, memanfaatkan limbah ikan sebagai pupuk untuk tanaman.
Agroforestry	Sistem penggunaan lahan yang mengintegrasikan pohon dengan tanaman pertanian dan/atau ternak untuk meningkatkan keberlanjutan dan keanekaragaman hayati.
Pemuliaan Tanaman (Plant Breeding)	Proses seleksi dan persilangan tanaman untuk menghasilkan varietas unggul.

Agrobotik	Penggunaan robot dalam kegiatan pertanian seperti panen, penyiangan, dan pemupukan.
Pertanian Berkelanjutan	Sistem pertanian yang menjaga produktivitas jangka panjang tanpa merusak lingkungan atau sumber daya alam.
Pertanian Cerdas Iklim (Climate-Smart Agriculture)	Praktik pertanian yang bertujuan untuk meningkatkan produktivitas, meningkatkan ketahanan terhadap perubahan iklim, dan mengurangi emisi gas rumah kaca.
Regenerative Agriculture	Praktik pertanian yang fokus pada pemulihan dan peningkatan kesehatan tanah, keanekaragaman hayati, dan ekosistem secara keseluruhan.
Pertanian Digital	Integrasi teknologi digital (sensor, AI, big data) dalam sistem pertanian modern.
Blockchain	Teknologi yang menyimpan data dalam buku besar sehingga data disimpan dalam blok. Setiap blok terhubung dengan blok lainnya sehingga terbentuklah blockchain, dan data ditransfer melalui jaringan peer-to-peer. Banyak fitur blockchain yang membuatnya berguna di semua bidang, karena didistribusikan, terdesentralisasi, dan aman, sehingga tidak diperlukan otoritas pusat, karena algoritma konsensus digunakan untuk mengarsipkan data dan mencapai

	kesepakatan antara node, di mana buku besar didistribusikan dan dikelola berdasarkan kesepakatan di antara semua node dalam jaringan
Agrivoltaik (Agri-PV)	Sistem pertanian ganda yang menggabungkan produksi energi surya dan pertanian di lahan yang sama. Panel surya memberikan naungan bagi tanaman, mengurangi suhu, dan meningkatkan efisiensi penggunaan lahan.
Controlled-Environment Agriculture (CEA)	Sistem pertanian yang dilakukan dalam lingkungan terkendali seperti rumah kaca atau bangunan bertingkat, menggunakan teknik seperti hidroponik dan aeroponik untuk menanam tanaman dengan kontrol lingkungan yang ketat.
Farm Management Software	(Perangkat Lunak Manajemen Pertanian) Program komputer yang membantu petani dalam merencanakan, memantau, dan mengelola operasi pertanian mereka, termasuk pengelolaan keuangan, sumber daya, dan produksi.

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PROFIL PENULIS

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ACTIVITIES

- I have been working at Oil & Gas Industry
- I have been studying for a doctorate 2024 in agribusiness at UPN "Veteran" Jawa Timur

EDUCATION

- (2003-2006) : Diploma 3 Electronics Engineering in Electronic Engineering Polytechnic Institute of Surabaya (EEPIS), D3 T.Elektronika Politeknik Elektronika Negeri Surabaya-ITS.
- (2012-2013) : D4 Instrumentation Engineering in PEM Akamigas-Cepu (under the Ministry of Energy and Mineral Resources of the Republic of Indonesia).
- (2019-2021) : Magister Mechanical Engineering in Sriwijaya University} S2 T.Mesin Universitas Sriwijaya Palembang.

EXPERIENCE

- (2007-2008) : 12 Months as technician for UPS & Datacard Machine at PT Bauma Kencana Murni.
- (2008-2009) : 16 Months as MSTT- Electric (Maintenance Senior Technician- Electric) at PT Total E&P Indonesie in East Borneo Province.
- (2009-2025) : 15 years in production & operation as Operator - ESP spv - CO2 Removal Plant spv - sr spv Gas Metering at PT Pertamina Hulu Energi - OSES {Pertamina Group}.

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