PERISHABLE AGRICULTURE

How technology can remove legacy issues and prepare the sector for today and beyond.

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Abstract

A breakthrough turnkey solution for perishable agriculture incorporating the latest in technology (blockchain, IoT, decentralized networks, etc. [1, 2]) does not currently exist to serve the needs of buyers and sellers within the sector [3]. It is a layered and complex issue that would require the integration of administration, documentation, buyer and seller matching, invoicing, payments and more. This paper identifies and breaks down existing pain points and discusses approaches to resolve those problems.

Background

The perishable agriculture industry as a whole is fragmented and disorganized [4,5]. Small to medium sized farm operators can be thought of as an archipelago, with clusters of islands varying in size but ultimately disconnected to other land masses. It is not without a sense of irony that capitalism does not financially reward independent producers of food - an essential component for the survival of humanity [6]. Instead, the number of growers of fresh fruits and vegetables have been steadily declining over the past decade as it is extremely difficult for farmers to access credit facilities to continue producing [7]. Current infrastructure requires these farmers to offer collateral in the form of their physical assets such as farmland, buildings or other hardware [8]. Any default payments due to poor harvest yields or unforeseen personal circumstances could trigger a lender to cancel their loan facilities, placing the farm business in jeopardy.

Legacy systems

Farmers and traders of fresh fruits and vegetables still use dated technology to run their businesses. Many companies in developed countries are still using fax, excel and email to keep track of their transactions.

Lack of trust between trading parties

Trading counter parties currently predominantly rely on banking networks to facilitate transactions and payments, meaning a bank would act as a mediator and controller of the flow of money. This service added value by enabling the sending party and receiving party to only need to trust the bank and not one another. Whilst this can be seen as reassuring, this introduces several other points of friction to their customers with the largest issue being the lack of transparency on what actually happens with the funds once a bank acknowledges receipt from the payer but has yet to credit the funds to the recipient [9,10]. This in turn could cause transacting counter parties to doubt one another when the matter is actually completely out of their hands. Banks are also limited to processing transactions to business hours, causing a great level of inconvenience to its customers [11]. Why should any business in 2022 be subject to delays of sending and receiving payments because an intermediary is closed when a transaction takes place after business hours or over the weekend?

Payment agreements for fresh produce

A farmer of fresh produce may agree to sell something to a wholesaler at a predetermined price but will often have to agree to only receive payment after between 30 - 90 days [12] to allow their clients to have credit, enabling enough cash flow for their client to run their businesses. A farmer is totally exposed in this situation as they will have already honoured their part of the agreement by sending their produce to their customer. If this client goes bankrupt or is unable to pay the invoice for any reason, the farmer will have no protection against this as insurance does not cover this sector [13].

Environment as a core consideration instead of a mere afterthought

Perishable agriculture is a multibillion dollar industry [14] with a scale that can make a notable difference to the environment if consistently applied globally. The compound effect of improvements in efficiency and minimization of waste can provide a meaningful contribution to reduce waste [15].

Limited access to funding

Farmers have very limited access to credit facilities. Funding is typically derived from collateralized borrowing from financial institutions like 1) banks or 2) private money lenders [16]. For banks, failure to pay monthly installments of loans could result in farmers losing their farm. Money lenders usually charge exorbitant amounts of interest as farmers have poor credit scores and limited options to borrow cash to pay for operational and production costs. There are currently no sustainable methods for farmers to access funding without sinking deeper into debt [17].

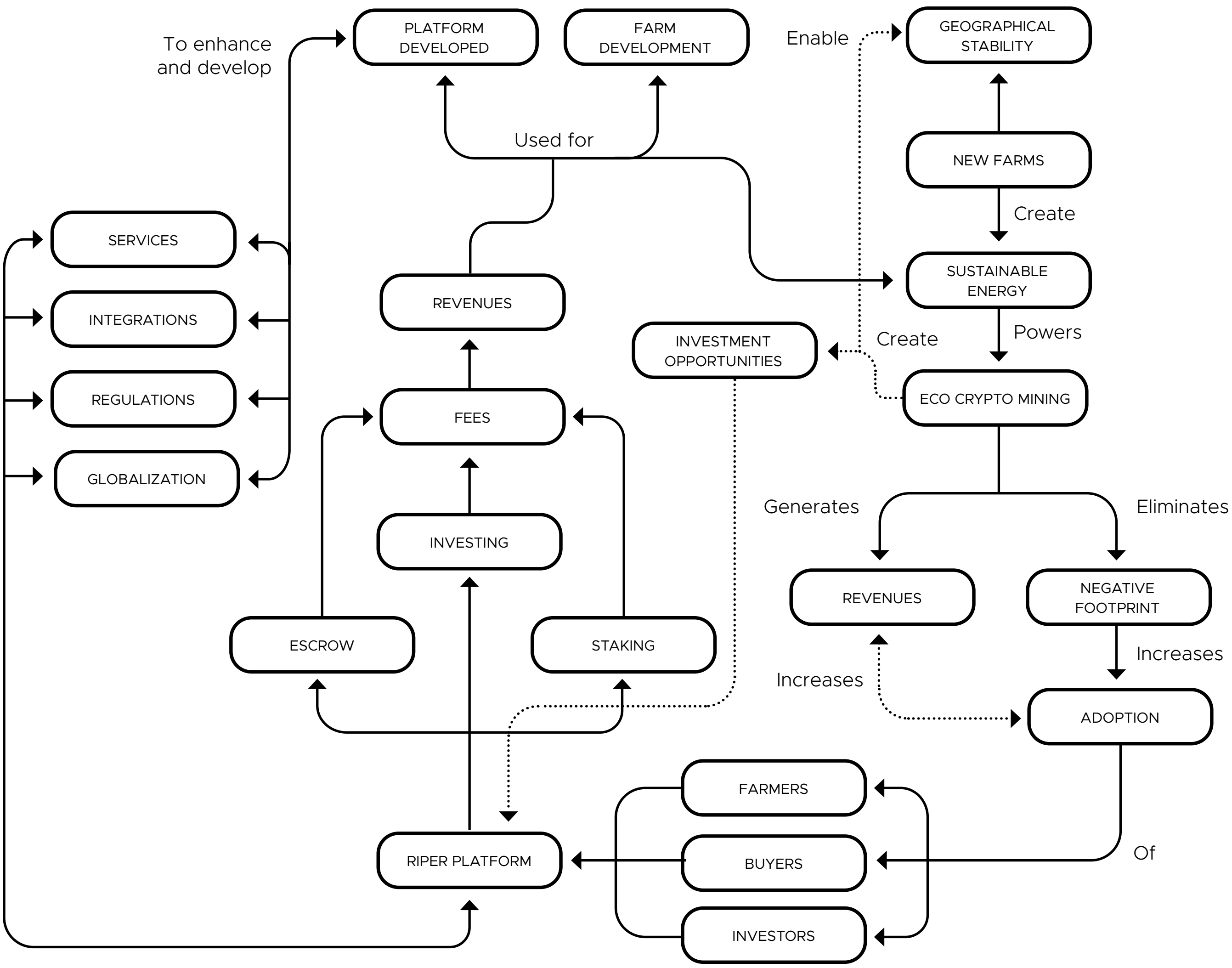
Extracting value from existing assets

Much of the byproducts produced on fresh fruit and vegetable farms can be recycled in some form [18]. This can be through grinding plant stems and leaves that provide no nutritional value as food and reintroducing it to soil to keep it fertile. Another example would be to collect farm waste from fruit, vegetable or animal farms nearby and turn that waste into energy. This energy will be clean and can be used to power machinery or sold to generate an additional income [19]. There is also a lack of methods to capture financial value along the entire product lifecycle of perishable goods. There should be ways for farmers and their clients to monetize any part of the process in which they deliver value.

The path to significant improvements

Based on the points raised above,
there needs to be:

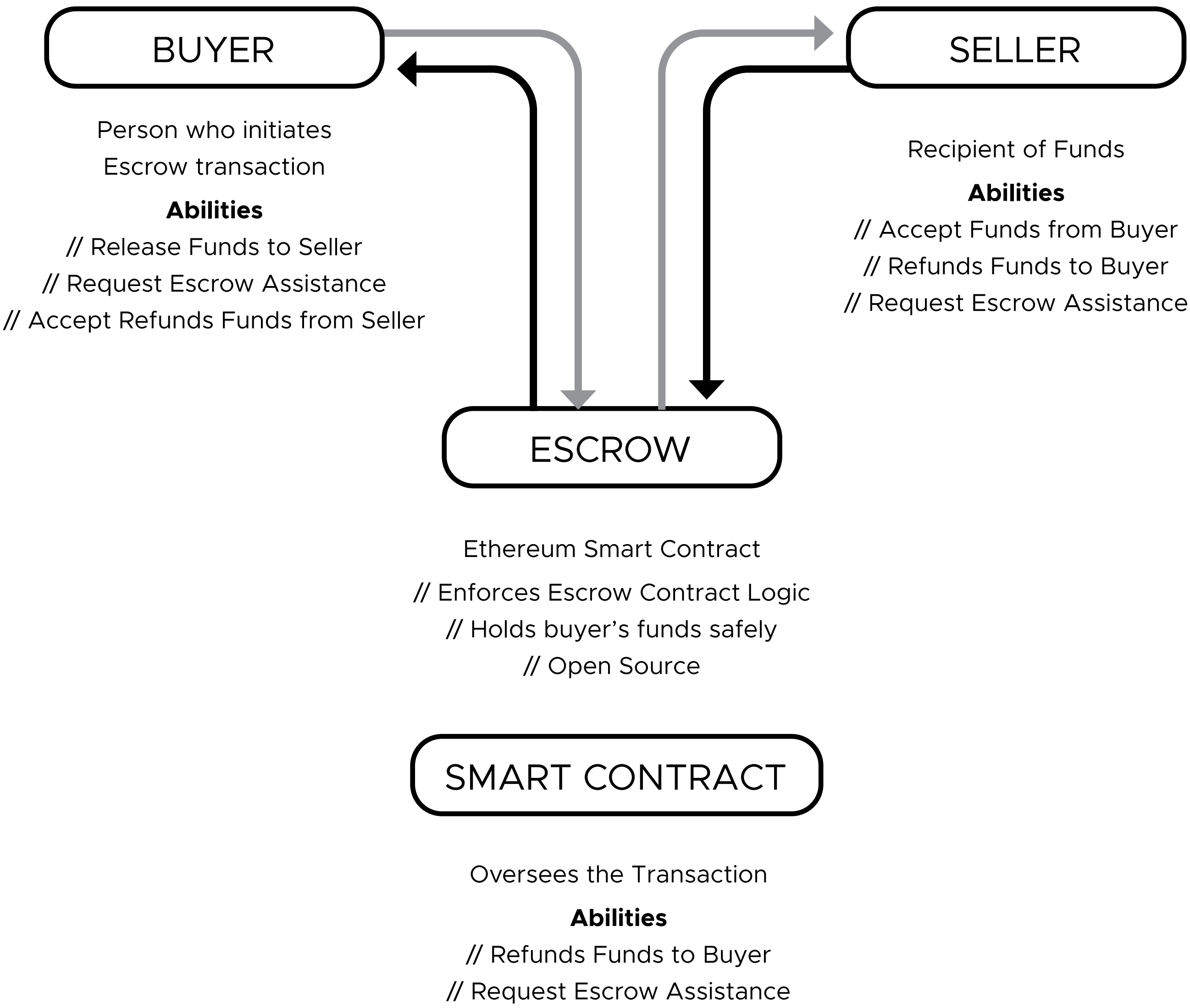
1. *developments on modernizing current processes for the sector*
2. *a method to navigate around trust issues between trading parties*
3. *prompt payments for farmers from their clients*
4. *greatly improved transparency for payments*
5. *faster transactions, available 24/7, 365 days a year*
6. *lower transaction costs*
7. *long term environmental sustainability*
8. *better funding access for farmers in perishable agriculture not tied to debt*
9. *value creation and financial capture*



Building trust between transactive parties

A neutral custodian service on blockchain to enable the safekeeping of funds can provide both trading parties with a safety net to ensure both parties honour the trade would be a single service that resolves the first 6 of the above 9 points listed.

This can be technically excecuted in a secure manner thanks to the recent advancement in blockchain technology and developer know-how. This service would be able to demonstrate how this space will greatly benefit from implementing such a product.



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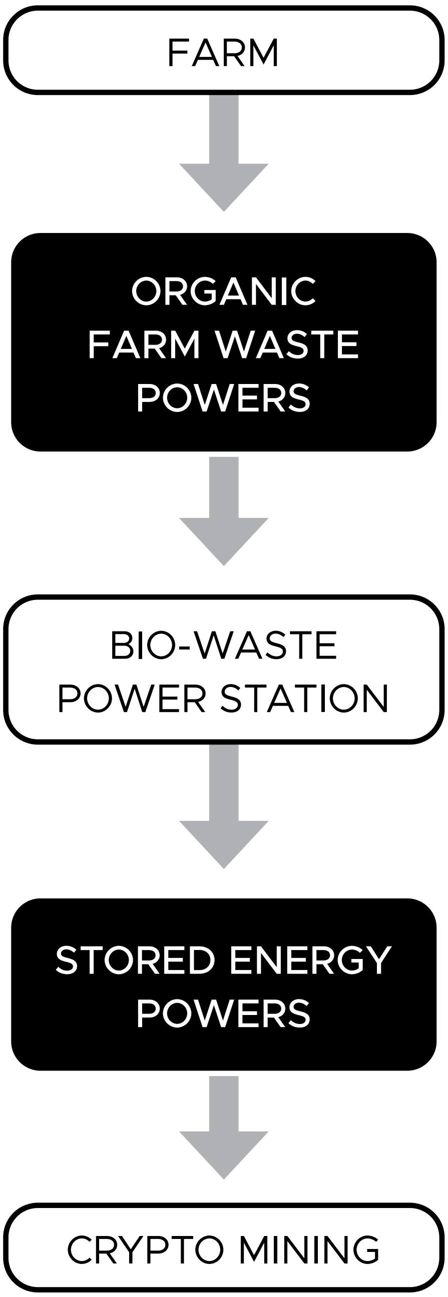
Better use for excess power

Larger farms that produce enough clean energy to power mining rigs for cryptocurrency such as Bitcoin. Proof of Work consensus networks have been contentious as they require extremely high amounts of processing power [20, 21]. This has drawn ire in those who have serious concerns about how harmful this technology is to the environment.

Energy that is purely derived from organic farm waste is a singular elegant solution to put these concerns to rest. This enables a complete shift in viability in crypto mining since it effectively creates an opportunity for farms to convert electrical energy into digital assets with real financial value. This has the potential to create a multiplicative effect on a farm's secondary revenue streams.



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Access to funding with a method to generate financial value

Smart contracts and blockchain networks have enabled decentralized finance to be deployed to provide funding via staking functions for attractive yields when compared to traditional finance. The same technology can also leverage token systems to present a novel approach to enable the value capture of ecosystems. Interactions within the ecosystem that provide value to other participants within the platform can be rewarded with tokens that have value in the secondary markets.

ERC-20 [22] and ERC-721 [23] standards have been popular in the crypto space for fungible and non-fungible use cases respectively. Each of these standards have been proven to function as expected and perform reliably. However, they do have their restrictions as they can only function as one or the other. The ERC-1155 [24, 25] standard enables the definition and configuration of both fungible tokens that may be used as a currency and/or NFTs that can serve as intellectual property. It allows a single smart contract to govern multiple tokens and token types, opening up advanced application and flexibility. The standard permits batch processing as well, potentially leading to significant savings in gas fees on the Ethereum network.

A nimble framework built to reward user participation in an ecosystem would be a more suitable choice of standard to be applied in this particular use case. While the finer technical details in development are beyond the scope of this paper, the overall framework for a platform designed to reward its participants is shown in the diagram below.

Smart Contracts

Every ERC-721 compliant contract must implement the ERC-721 and ERC-165 interfaces

```
pragma solidity ^0.4.20;
/// @title ERC-721 Non-Fungible Token Standard
/// @dev See https://eips.ethereum.org/EIPS/eip-721
///  Note: the ERC-165 identifier for this interface is 0x80ac58cd.
interface ERC721 /* is ERC165 */ {
    /// @dev This emits when ownership of any NFT changes by any mechanism.
    ///  This event emits when NFTs are created (`from` == 0) and destroyed
    ///  (`to` == 0). Exception: during contract creation, any number of NFTs
    ///  may be created and assigned without emitting Transfer. At the time of
    ///  any transfer, the approved address for that NFT (if any) is reset to none.
    event Transfer(address indexed _from, address indexed _to, uint256 indexed _tokenId);
    /// @dev This emits when the approved address for an NFT is changed or
    ///  reaffirmed. The zero address indicates there is no approved address.
    ///  When a Transfer event emits, this also indicates that the approved
    ///  address for that NFT (if any) is reset to none.
    event Approval(address indexed _owner, address indexed _approved, uint256 indexed _tokenId);
    /// @dev This emits when an operator is enabled or disabled for an owner.
    ///  The operator can manage all NFTs of the owner.
    event ApprovalForAll(address indexed _owner, address indexed _operator, bool _approved);
    /// @notice Count all NFTs assigned to an owner
    /// @dev NFTs assigned to the zero address are considered invalid, and this
    ///  function throws for queries about the zero address.
    /// @param _owner An address for whom to query the balance
    /// @return The number of NFTs owned by `_owner`, possibly zero
    function balanceOf(address _owner) external view returns (uint256);
    /// @notice Find the owner of an NFT
    /// @dev NFTs assigned to zero address are considered invalid, and queries
```

Smart contracts implementing all of the functions in the ERC-1155 interface.

```
pragma solidity ^0.5.9;
/**
    @title ERC-1155 Multi Token Standard
    @dev See https://eips.ethereum.org/EIPS/eip-1155
    Note: The ERC-165 identifier for this interface is 0xd9b67a26.
 */
interface ERC1155 /* is ERC165 */ {
    /**
        @dev Either `TransferSingle` or `TransferBatch` MUST emit when tokens are
        transferred, including zero value transfers as well as minting or burning (see
        "Safe Transfer Rules" section of the standard).
        The `_operator` argument MUST be the address of an account/contract that is
        approved to make the transfer (SHOULD be msg.sender).
        The `_from` argument MUST be the address of the holder whose balance is
        decreased.
        The `_to` argument MUST be the address of the recipient whose balance is
        increased.
        The `_id` argument MUST be the token type being transferred.
        The `_value` argument MUST be the number of tokens the holder balance is
        decreased by and match what the recipient balance is increased by.
        When minting/creating tokens, the `_from` argument MUST be set to `0x0` (i.e.
        zero address).
        When burning/destroying tokens, the `_to` argument MUST be set to `0x0` (i.e.
        zero address).
    */
    event TransferSingle(address indexed _operator, address indexed _from, address indexed _to,
    uint256 _id, uint256 _value);
    /**
```

Conclusion

Longstanding issues within the fresh produce industry have been highlighted in this document. The 9 key issues identified can be resolved by applying 3 distinct strategies to encompass all points listed. Though the applications of these methods to this particular sector are brand new, the technology is commonly applied and mature enough to be implemented into business environments to warrant an investment due to the high potential in a positive upside. Each of the proposed solutions can lead to a marked difference in the way trade in perishable goods is currently conducted. This is a strong market opportunity to change market practices for the better.

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