Ajayu Agri-Fintech

Predictive Model & Financial Calculation Framework

Jose Carlo Burga

This document outlines the full suite of predictive models, data workflows, and financial logic supporting the investment case and operations for Ajayu Agri Fintech.

MODEL OVERVIEW & FUNCTIONAL FLOW

Model Name	Purpose	Key Outputs	Used For	Core Formula	
1. Credit Scoring Model	Evaluate farmer creditworthiness using production, location, export alignment, and climate risk	Risk score, recommended loan amount and interest rate	Lending qualification and pricing	$\text{RiskScore} = \sigma(\beta_0 + \sum_{i=1}^{n} \beta_i X_i)$	Write something...
2. FOB Revenue Forecasting	Predict district-level export performance (monthly, by product)	Revenue outlook, volatility score	Adjust credit ceilings, target products and locations	$\hat{Y}_t = \alpha + \sum_{i=1}^{p} \phi_i Y_{t-i} + \sum_{j=1}^{q} \theta_j \epsilon_{t-j} + \gamma Z_t$	
3. Parametric Insurance Trigger	Identify payout triggers using weather and price anomalies	Insurance flag, premium range	Automated coverage and pricing	$\text{Trigger} = 1 \text{ if } X_t \notin [\mu - k\sigma, \mu + k\sigma]$	
4. Farmer Segmentation	Cluster farmers by productivity, exporter alignment, and tech adoption	Segment label (A/B/C), onboarding tier	Tailored loan + grant bundles	$\arg\min_S \sum_{i=1}^{k} \sum_{x \in S_i} \|\|x - \mu_i\|\|^2$	
5. Repayment Behavior Model	Predict likelihood of timely repayment	Probability of repayment	Risk management and early warning	(P(y=1	X) = \frac{1}{1 + e^{-\beta^T X}})

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DATA PIPELINE FLOW

Input Datasets:

- **ENA (Encuesta Nacional Agropecuaria):** Farmer profiles, crops, yields, access to inputs (source)
- **CENAGRO 2012:** Land use, farmer classification, national geostatistics (source)
- **SUNAT G3:** Monthly FOB export revenue by product (G3 Excel)
- **SUNAT G5:** Export destinations per product and value (G5 Excel)
- **SUNAT G6:** Country codes and destination market classification (e.g., US, EU, APEC) (G6 Excel)
- **UBIGEO Tables:** Region/province/district geocodes (INEI catalog)
- **Climate Data:** SENAMHI, NOAA APIs – precipitation, drought index, temperature

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FEATURE ENGINEERING (from Ajayu PPTX Architecture)

Key derived features used in predictive models:

Feature	Source(s) from Pipeline	How It's Engineered
FOB_Alignment_Score	SUNAT G3, UBIGEO	Compare monthly district-level FOB trends against national top 15 crop FOB vectors (correlation or cosine similarity)
Climate_Risk_Index	Climate Data, UBIGEO	Compute normalized multi-year anomaly scores (e.g., SPI, temperature z-scores)
Traceability_Link	ENA, SUNAT G5/G6, Exporter registry	Binary flag indicating if farmer/product is part of a known export supply chain
Tech_Adoption_Index	ENA, CENAGRO	Scored on irrigation, mechanization, fertilizer use, and mobile access
Digital_Engagement	Ajayu platform (mobile onboarding logs)	Frequency of interaction, onboarding success, message exchange
Market_Exposure	SUNAT G5 + G6	Proportion of production linked to US/EU/APEC exports by destination
Historical_Default_Rate	Ajayu repayment logs (ongoing)	Aggregated repayment behavior by UBIGEO-product-time cluster
Onboarding_Segment	Derived from ENA, CENAGRO, FOB	Clustering via KMeans or HDBSCAN on productivity, tech, geography, and risk

These features feed into model input pipelines and dynamically update risk and pricing decisions.

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FINANCIAL LOGIC & CALCULATIONS

Ajayu's financial framework integrates predictive analytics to estimate revenue generation, capital allocation efficiency, and platform scalability. All projections are derived from AI-driven farmer segmentation, credit scoring, and export-alignment forecasts.

A. Revenue Model (Predictive Basis)

- **Platform Fee Prediction**: Based on expected onboarding and engagement scores, farmers are projected to yield \$5/month × engagement probability.
- **Loan Revenue Estimation**: Using the credit scoring model, loan disbursement is dynamically optimized. The blended return (6%) is applied over predictive deployment curves.

Example Y1 (5,000 farmers with 80% engagement and 90% disbursement rate):

- Platform: 5,000 × \$60 × 0.8 = \$240,000
- Loans: \$7.5M × 0.9 × 6% = \$405,000
- Total: ~\$645,000, scalable to \$1.45M including insurance-trigger volatility and product clustering

B. Valuation Formula (Model-Driven Multiples)

- Valuation = Expected Revenue × Revenue Multiple
- Multiples:
  - Seed: 6–8× for early-stage risk with tech/data edge
  - Series A: 6–8× with traction and geographic expansion
  - Series B: 7–10× due to regional scale and embedded ETF infrastructure

C. Capital Allocation Strategy (AI-Optimized)

- 70%: Loan capital driven by segmented farmer credit models
- 20%: Platform development prioritized by usage telemetry and model load factors
- 10%: Operations scaled according to model-predicted growth trajectories

D. Market Size Estimation (Data-Grounded TAM)

- 900,000 export-aligned farmers mapped via ENA, CENAGRO, SUNAT
- Avg. loan need: \$2,000 → \$1.6B modeled lending volume
- Adding platform fees, insurance probability: \$2B+ total addressable market

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OUTPUT & SYSTEM INTEGRATION

Ajayu Digital Platform

- Mobile onboarding via WhatsApp
- Exporter-led clustering via traceability APIs
- Geo-located loan + grant decisions
- Dynamic dashboard with model outputs + alerts

Investor Reports

- Dashboard showing:
  - Capital deployment and return
  - Insurance trigger history
  - FOB-export alignment per region

Institutional Alignment

- Designed to complement AGAP exporters, COFIDE lending strategy, and future ETF fund indexing

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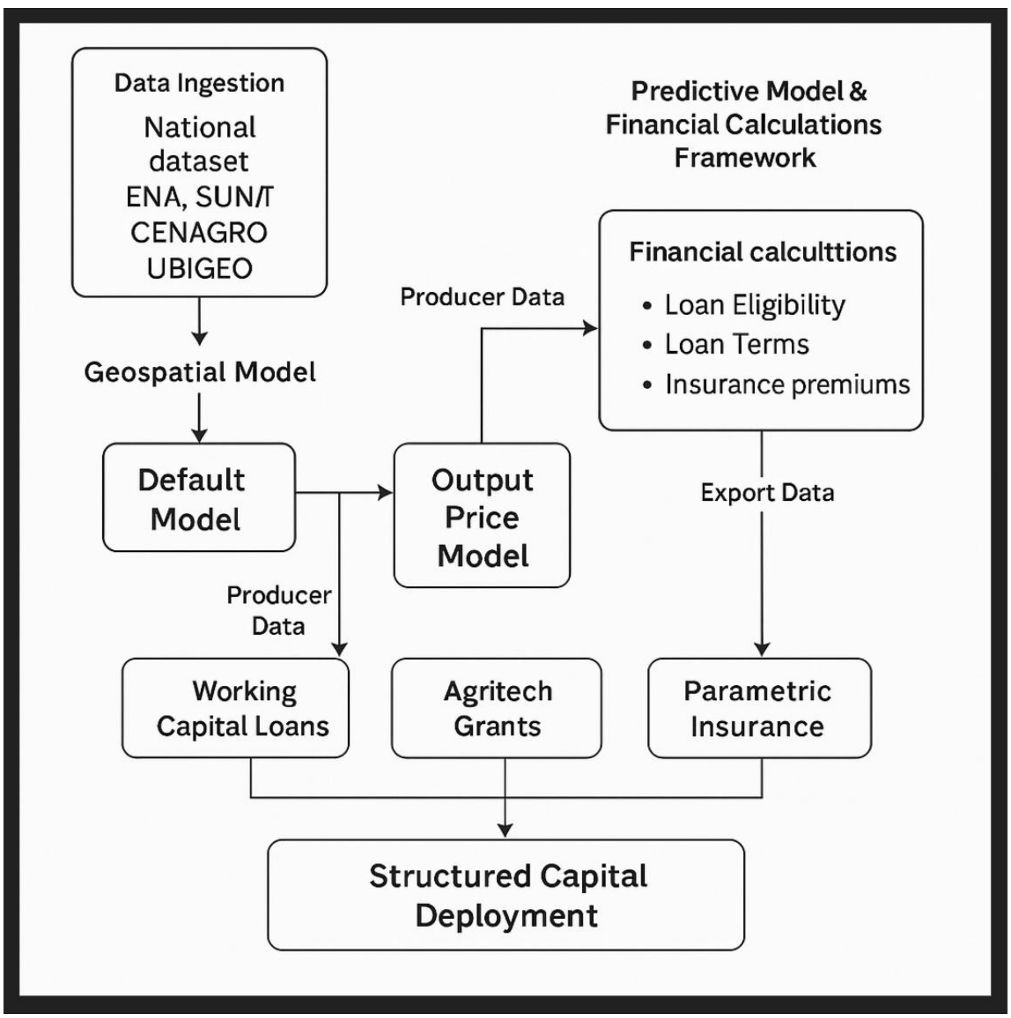
ARCHITECHTURE WORKFLOW



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PYTHON DATA PROCESSING

1. Clean and Normalize ENA by UBIGEO

```
ena = pd.read_csv('ENA_2023.csv')
ena['UBIGEO'] = ena['REGION'].astype(str).str.zfill(2) + ena['PROVINCIA'].astype(str).
ena = ena.dropna(subset=['CULTIVO_PRINCIPAL', 'RENDIMIENTO'])
```

2. Merge with CENAGRO for Land Use Mapping

```
cenagro = pd.read_csv('CENAGRO_2012.csv')
data = ena.merge(cenagro, on='UBIGEO', how='left')
```

3. Integrate G3 Export Revenue by Crop and Geography

```
g3 = pd.read_excel('cdro_G3.xlsx', sheet_name='2023')
g3['FOB'] = pd.to_numeric(g3['FOB'], errors='coerce')
g3 = g3.groupby(['PRODUCTO', 'UBIGEO', 'MES'])['FOB'].sum().reset_index()
data = data.merge(g3, on=['PRODUCTO', 'UBIGEO'], how='left')
```

4. Link Destination Markets (G5 + G6)

```
g5 = pd.read_excel('cdro_G5.xlsx')
g6 = pd.read_excel('cdro_G6.xlsx')
g5 = g5.merge(g6, on='PAIS_CODIGO', how='left')
g5_filtered = g5[g5['REGION_DESTINO'].isin(['EE.UU.', 'APEC', 'UE'])]
```

5. Add Climate Index and Anomalies

```
climate = fetch_climate_data(df['UBIGEO'], df['MES'])
data = data.merge(climate, on=['UBIGEO', 'MES'], how='left')
data['anomaly_flag'] = (data['RAINFALL'] < threshold_low) | (data['RAINFALL'] > thresh
```

6. Historical FOB Alignment Curve

```
fob_curves = g3.groupby(['PRODUCTO', 'UBIGEO', 'MES'])['FOB'].mean().unstack('MES').fi
```

7. Final Model Feed Format

```
model_input = data[['UBIGEO', 'PRODUCTO', 'RENDIMIENTO', 'FOB', 'anomaly_flag', 'SEGME
```

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MODEL 1

1. Credit Scoring Model (XGBoost)

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```python
import pandas as pd
import xgboost as xgb
from sklearn.model_selection import train_test_split
from sklearn.metrics import roc_auc_score

# Load data
df = pd.read_csv('farmer_credit_dataset.csv')

# Features and label
X = df[['age', 'region_code', 'production_volume', 'fob_alignment_score',
        'prev_loan_access', 'climate_risk_index']]
y = df['default']

# Train model
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2)
model = xgb.XGBClassifier(n_estimators=100, max_depth=4)
model.fit(X_train, y_train)

# Predict risk
new_farmer = pd.DataFrame([{
    'age': 42,
    'region_code': 101,
    'production_volume': 12.5,
    'fob_alignment_score': 0.78,
    'prev_loan_access': 1,
    'climate_risk_index': 0.25
}])
risk_score = model.predict_proba(new_farmer)[0][1]
```

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MODEL 2

2. FOB Revenue Forecasting (SARIMAX + ML Hybrid)

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```python
import pandas as pd
from statsmodels.tsa.statespace.sarimax import SARIMAX

# Load and preprocess time series data
df = pd.read_csv('fob_monthly_exports.csv', parse_dates=['date'])
df.set_index('date', inplace=True)

# Train SARIMAX for one product
model = SARIMAX(df['fob_value'], order=(1,1,1), seasonal_order=(1,1,0,12))
results = model.fit()

# Forecast next 6 months
forecast = results.forecast(steps=6)
```

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MODEL 3

3. Parametric Insurance Trigger (Anomaly Detection)

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```python
import pandas as pd
from sklearn.ensemble import IsolationForest

# Load historical FOB prices or rainfall
df = pd.read_csv('climate_and_price_data.csv')

# Train isolation forest for anomaly detection
clf = IsolationForest(contamination=0.05)
df['anomaly'] = clf.fit_predict(df[['rainfall_mm', 'fob_price_usd']])

# Trigger logic
df['trigger_insurance'] = df['anomaly'] == -1
```

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MODEL 4

4. Farmer Segmentation (HDBSCAN or KMeans)

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```python
import pandas as pd
from sklearn.cluster import KMeans

# Load dataset
df = pd.read_csv('farmer_profile_data.csv')

# Clustering based on productivity, tech adoption, exporter proximity
X = df[['yield_per_hectare', 'tech_index', 'exporter_linkage_score']]
kmeans = KMeans(n_clusters=3)
df['segment'] = kmeans.fit_predict(X)
```

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<u>MODEL 5</u>

5. Loan Repayment Behavior Predictor (Logistic Regression)

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```python
import pandas as pd
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import train_test_split

# Load repayment data
df = pd.read_csv('repayment_behavior.csv')

X = df[['loan_amount', 'platform_engagement_score', 'expected_yield', 'historical_repayment_rate']
y = df['repayment_on_time']

# Train logistic regression model
X_train, X_test, y_train, y_test = train_test_split(X, y)
model = LogisticRegression()
model.fit(X_train, y_train)

# Predict repayment probability
repayment_prob = model.predict_proba(X_test)[:, 1]
```