APPENDICES

Appendix 1. GEE Script to Download Band 4, Band 8 and NDVI Data

```
// study area and survey data
var studyArea = ee.FeatureCollection(pts); // Data titik/piksel yg dikumpulkan
var surveyData = ee.FeatureCollection(pts); // Visualisasi titik

//  Fungsi NDVI
function getNDVI(image) {
    var ndvi = image.normalizedDifference(['B8','B4']).rename("ndvi");
    image = image.addBands(ndvi);
    return image;
}

// var inBands = ee.List(['QA60','B1','B2','B3','B4','B5','B6','B7','B8','B8A','B9','B11','B12']);
// var outBands =
ee.List(['QA60','cb','blue','green','red','re1','re2','re3','nir','re4','waterVapor','swir1','swir2']);

//masking awan citra sentinel
function maskS2clouds(image) {
  var qa = image.select('QA60');

  // Bits 10 and 11 are clouds and cirrus, respectively.
  var cloudBitMask = 1 << 10;
  var cirrusBitMask = 1 << 11;

  // Both flags should be set to zero, indicating clear conditions.
  var mask = qa.bitwiseAnd(cloudBitMask).eq(0)
      .and(qa.bitwiseAnd(cirrusBitMask).eq(0));

  return image.updateMask(mask).divide(10000).copyProperties(image).set('system:time_start',
image.get('system:time_start'));
}

//Parameter Citra Sentinel 2
var s2 = ee.ImageCollection('COPERNICUS/S2_SR')
                .filterDate('2019-1-01', '2019-1-31')
                // Pre-filter to get less cloudy granules.
                // .filter(ee.Filter.lt('CLOUDY_PIXEL_PERCENTAGE',80))
                .filterBounds(pts) //titik survei
                //.select(inBands,outBands)
                .map(maskS2clouds);

// print(s2);

// Pemilihan band sentinel
var nir = s2.select('B8')//.first();
// Map.addLayer(nir, {min: 0, max: 0.8}, 'nir');

var red = s2.select('B4')//.first();
// Map.addLayer(red, {min: 0, max: 0.8}, 'red');

// var NDVI1 = nir.subtract(red).divide(nir.add(red)).rename('NDVIS2');
// print(NDVI1);
```

```
// var L = 0.5;
// var SAVI = (nir.subtract(red).divide(nir.add(red))).multiply(1 + L).rename('SAVI');
// print('images');
// // print(study.first())
// print(SAVI);

// function addsa(input) {
//   var s2 = ee.Image().expression('(((NIR-Red)/(NIR+Red))*1.5)', {
//     NIR: input.select('B8').multiply(0.0001),
//     Red: input.select('B4').multiply(0.0001)
//   }).rename('savi');
//   return input.addBands(s2);
// }

// function addsa(input){
//   var NIR = input.select('B8');
//   var RED = input.select('B4');
//   var sa_neu = NIR.subtract(RED);
//   var sa_deno = NIR.add(RED).add(0.5);
//   var sa = sa_neu.multiply(1.5).divide(sa_deno).rename('savi');
//   return sa;
// }

// var savis2 = s2.map(addsa).max().clip(area);
// print(savis2);

// var savis22 = savis2.select('savi').clip(area)
// // .filterBounds(area);
// print(savis22);

// // for savi
// var Vis = {
//   min: 0.0,
//   max: 0.6,
//   palette: [
//     'FFFFFF', 'CE7E45', 'DF923D', 'F1B555', 'FCD163', '99B718', '74A901',
//     '66A000', '529400', '3E8601', '207401', '056201', '004C00', '023B01',
//     '012E01', '011D01', '011301'
//   ],
// };

// Map.addLayer(savis2, Vis, 'SAVI');


var s2sel = s2.select(['B8', 'B4']);
// print(s2sel);

var study1 = s2sel.map(getNDVI);
// print('images')
// print(study1.first())

/// TIMESERIES CHART FOR SINGLE LOCATION ///
var chart = ui.Chart.image.series({
   imageCollection: study1.select('B4', 'B8', 'ndvi'),
```

```
    region: surveyData.geometry()
    }).setOptions({
      interpolateNulls: true,
      lineWidth: 1,
      pointSize: 3,
      title: 'RED, NIR, NDVI over Time at a Single Location',
      vAxis: {title: 'Nilai'},
      hAxis: {title: 'Date', format: 'YYYY-MMM', gridlines: {count: 12}}
    })
print(chart)


// // map to map layers
var study = study1.mean()//.clip(studyArea);
Map.centerObject(surveyData);
// Map.addLayer(s2, {'min':0,'max':3000,'bands':"B4,B3,B2"}, "S2");
Map.addLayer(s2, {'min':0,'max':0.3,'bands':"B4,B3,B2"}, "S2");

// for ndvi
var Vis = {
  min: 0.0,
  max: 1,
  palette: [
    'FFFFFF', 'CE7E45', 'DF923D', 'F1B555', 'FCD163', '99B718', '74A901',
    '66A000', '529400', '3E8601', '207401', '056201', '004C00', '023B01',
    '012E01', '011D01', '011301'
  ],
};


// NDVI to map layers
var studyNDVI = study1.select('ndvi');
// print(studyNDVI);
Map.addLayer(studyNDVI, Vis, 'NDVI');

var studyRED = study1.select('B4');
// print(studyRED);


// // Survey data to map layers
Map.addLayer(surveyData,{color:'FF0000'},'surveyData');

// var s2mer = ee.Image.cat(study, SAVI)
//   // Computed images do not have a 'system:time_start' property; add one based
//   // on when the data were collected.
//   .set('system:time_start', ee.Date('2000-01-01').millis());

// // Wrap the single image in an ImageCollection for use in the zonalStats function.
// var s2Col = ee.ImageCollection([s2mer]);
// print(s2Col);

// Get Zonal Statistics
// var reduced = study.reduceRegions({
//   collection: surveyData,
//   reducer: ee.Reducer.mean(),
```

```
//   scale: 10,
//   });
// print(reduced);

/// HANDLING MASKED PIXELS ///
var reduced = study1.map(function(image) {
  return image.reduceRegions({
    collection: pts,
    reducer: ee.Reducer.mean(),//.setOutputs(['B4', 'B8', 'ndvi']),
    scale: 10,
  })// reduceRegion doesn't return any output if the image doesn't intersect
    // with the point or if the image is masked out due to cloud
    // If there was no ndvi value found, we set the ndvi to a NoData value -9999
    .map(function(feature) {
    var ndvi = ee.List([feature.get('ndvi'), 0])
      .reduce(ee.Reducer.firstNonNull())
    var B4 = ee.List([feature.get('B4'), 0])
      .reduce(ee.Reducer.firstNonNull())
    var B8 = ee.List([feature.get('B8'), 0])
      .reduce(ee.Reducer.firstNonNull())
    return feature.set({'B4': B4,'B8': B8,  'ndvi': ndvi, 'imageID': image.id()})
    })
  }).flatten();

print(reduced)

// so you can export it as a table
Export.table.toDrive({
    collection: reduced,
    description: 'B1',
    folder: 'BATCH 1',
    fileNamePrefix: 'B1',
    fileFormat: 'CSV',
});
```

Appendix 2. Best Beta GLMM Model Output for Central Kalimantan and Karawang

a. Best Beta GLM/GLMM Model Output for Karawang

```
Family: beta  ( logit )
Formula:
Y2 ~ X21 + X22 + Lag0 + Lag2 + +rlag0 + rlag1 + nlag0 + nlag2 +
    (1 | Farmer)
Data: Train

     AIC      BIC   logLik deviance df.resid
 -195.8   -169.2    108.9   -217.8       72

Random effects:

Conditional model:
 Groups Name     Variance  Std.Dev.
  Farmer (Intercept) 2.873e-09 5.36e-05

Dispersion parameter for beta family ():   56

Conditional model:
      Estimate Std. Error z value Pr(>|z|)
(Intercept) -3.440e-01  1.906e-01  -1.805   0.0711 .
X21          7.032e-04  4.082e-04   1.722   0.0850 .
X22          5.432e-04  3.293e-04   1.650   0.0990 .
Lag0         2.642e+00  1.541e+00   1.715   0.0864 .
Lag2         7.952e+00  1.418e+00   5.607 2.05e-08 ***
rlag0       -1.319e+01  2.297e+00  -5.740 9.48e-09 ***
rlag1        1.405e+00  4.666e-01   3.011   0.0026 **
nlag0        5.548e+00  7.700e-01   7.205 5.81e-13 ***
nlag2        4.156e-01  2.220e-01   1.872   0.0612 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

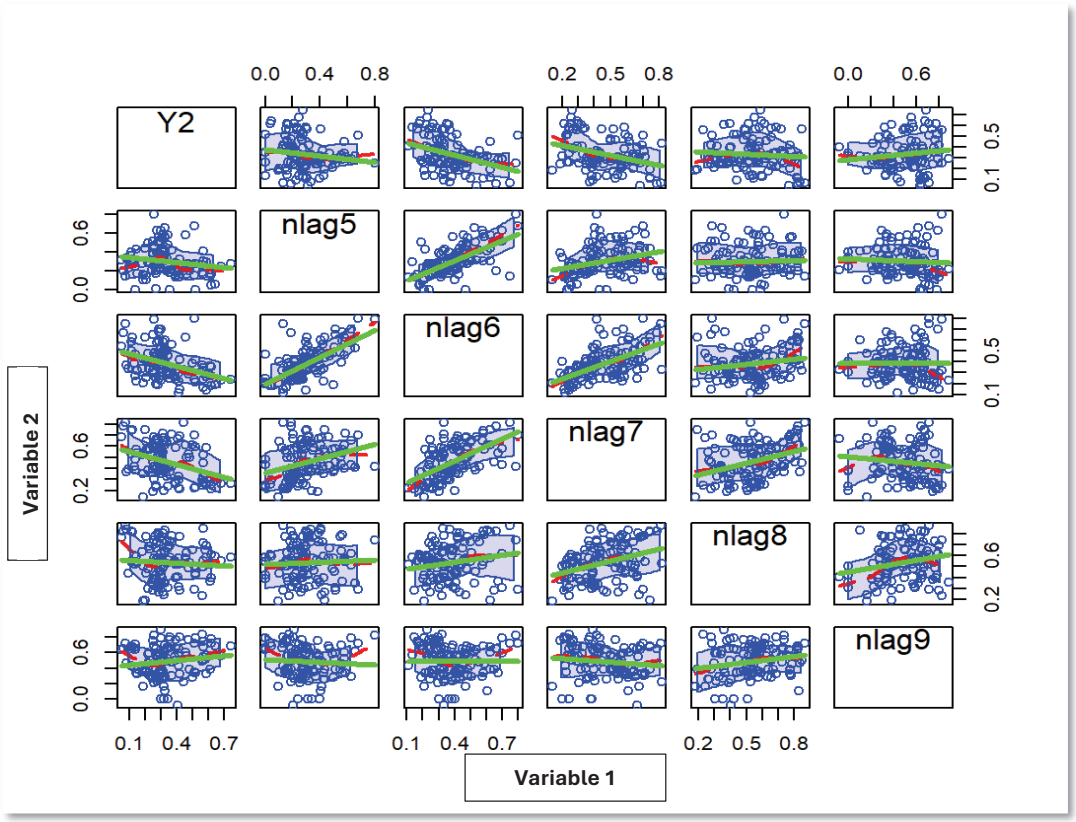
b. Best Beta GLM/GLMM Model Output for Central Kalimantan

```
Family: beta ( logit )
Formula:
Y2 ~ X1_2 + X2_2 + X7_2 + Lag0 + Lag1 + Lag2 + Lag3 + Lag4 +
    Lag5 + Lag6 + rlag0 + rlag1 + rlag2 + rlag3 + rlag4 + rlag5 +
    rlag6 + nlag0 + nlag1 + nlag2 + nlag3 + nlag4 + nlag5 + nlag6 +
    (1 | Farmer) + (1 | X9_2/X11_2)


Data: Train

     AIC      BIC   logLik deviance df.resid
  -124.1    -38.0     96.1   -192.1       59
```

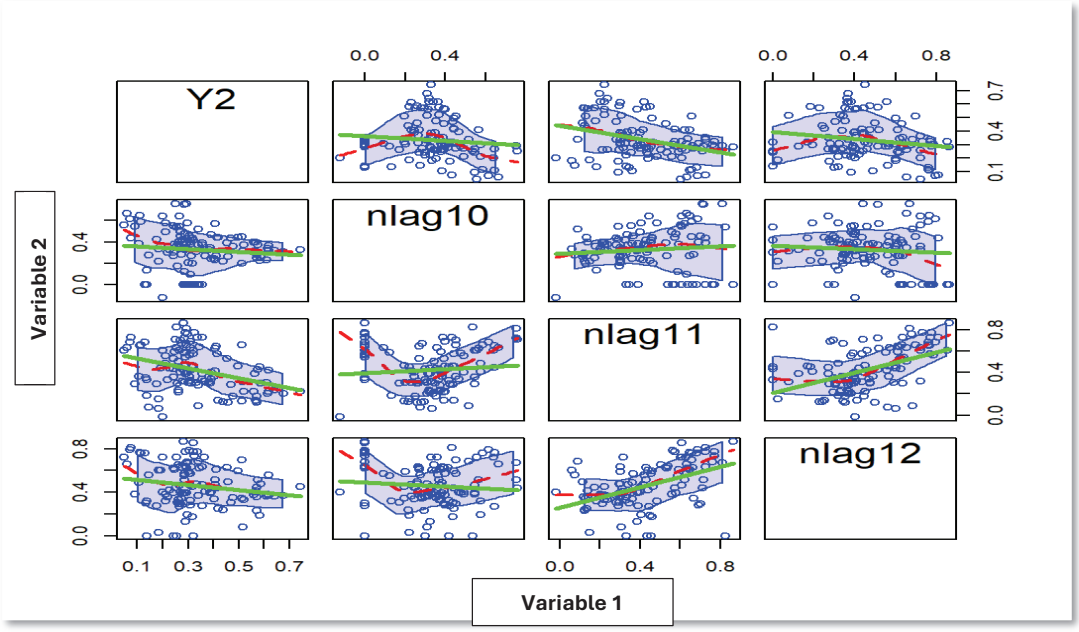
```
Random effects:

Conditional model:
 Groups     Name        Variance  Std.Dev.
 Farmer     (Intercept) 1.146e-16 1.071e-08
 X11_2:X9_2 (Intercept) 1.110e-01 3.332e-01
 X9_2       (Intercept) 5.130e-10 2.265e-05

Dispersion parameter for beta family (): 30.3

Conditional model:
                 Estimate Std. Error z value Pr(>|z|)
(Intercept)      -1.81843    0.63938  -2.844 0.004455 **
X1_2Moderate      0.24131    0.19192   1.257 0.208632
X1_2Mild         -0.18926    0.24735  -0.765 0.444175
X2_2Moderate      0.72800    0.17752   4.101 4.11e-05 ***
X2_2Mild          0.58116    0.19088   3.045 0.002329 **
X2_2Not Affected  0.88181    0.53188   1.658 0.097338 .
X7_2Mechanical   -1.19953    0.47454  -2.528 0.011480 *
X7_2Biological   -1.14213    0.55682  -2.051 0.040249 *
X7_2Chemical     -0.85118    0.23672  -3.596 0.000324 ***
Lag0              3.73704    2.20249   1.697 0.089747 .
Lag1              0.07569    1.61981   0.047 0.962731
Lag2             -1.89000    2.27391  -0.831 0.405879
Lag3              4.58145    3.64984   1.255 0.209389
Lag4              0.85889    3.77000   0.228 0.819784
Lag5              8.97062    4.05956   2.210 0.027122 *
Lag6             -0.37596    3.45639  -0.109 0.913383
rlag0            -1.61832    1.39980  -1.156 0.247635
rlag1             0.39738    1.12494   0.353 0.723905
rlag2             1.46704    1.61390   0.909 0.363350
rlag3            -2.85317    3.05267  -0.935 0.349970
rlag4            -0.51816    3.24917  -0.159 0.873295
rlag5            -5.47765    3.33453  -1.643 0.100444
rlag6            -0.10927    2.55078  -0.043 0.965832
nlag0             0.79306    0.56518   1.403 0.160559
nlag1            -0.16513    0.44944  -0.367 0.713310
nlag2            -0.42297    0.63463  -0.666 0.505101
nlag3             1.98545    1.17256   1.693 0.090406 .
nlag4             0.17702    1.48342   0.119 0.905012
nlag5             3.32027    1.34542   2.468 0.013593 *
nlag6            -1.32793    1.28360  -1.035 0.300886
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Appendix 3. Scatterplot between Paddy Productivity of Sentinel 2A's NDVI, Band 4m and Band 8 data

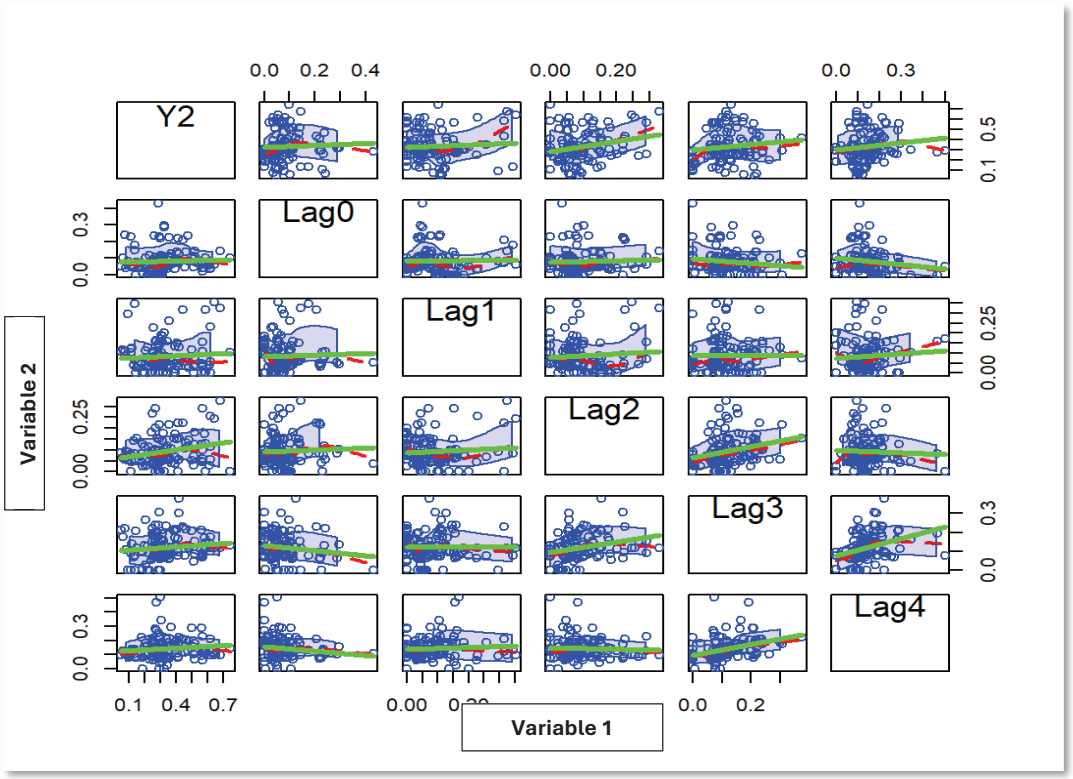
a. Scatterplot between the paddy productivity and lags five to lag nine NDVI values



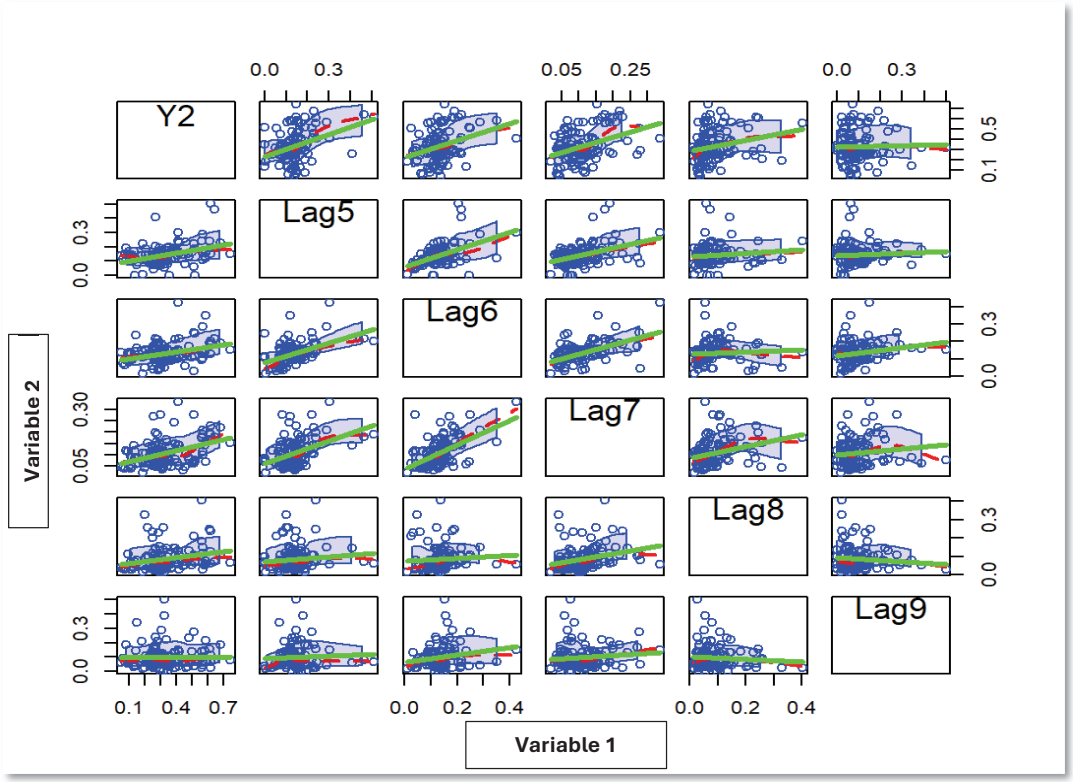
b. Scatterplot between the paddy productivity and lags ten to lag twelve NDVI values



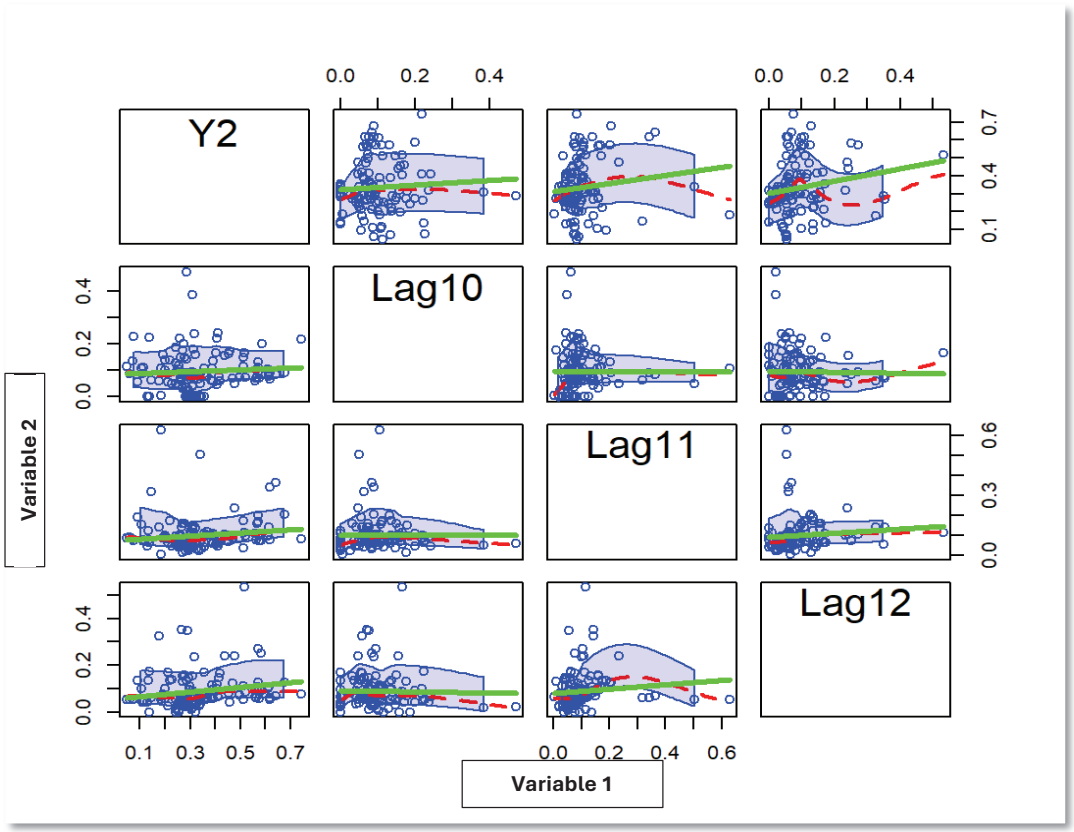
c. Scatterplot between the paddy productivity, current Band 4, and lag one to lag four Band 4 values



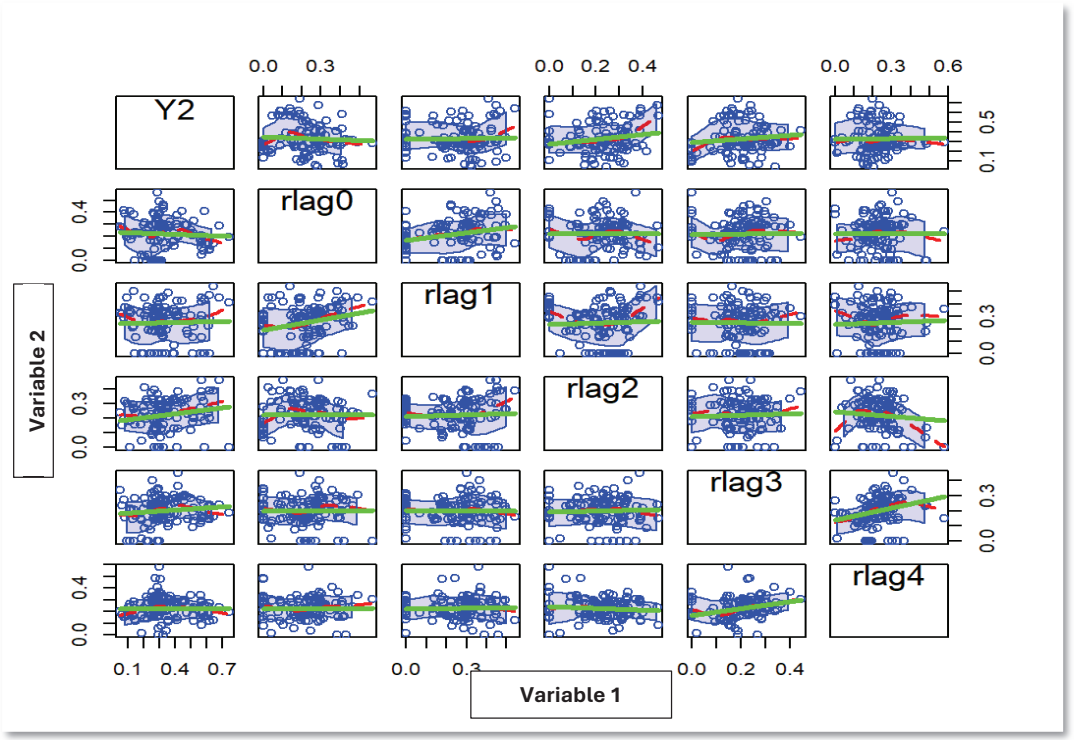
d. Scatterplot between the paddy productivity and lags five to lag nine Band 8 values



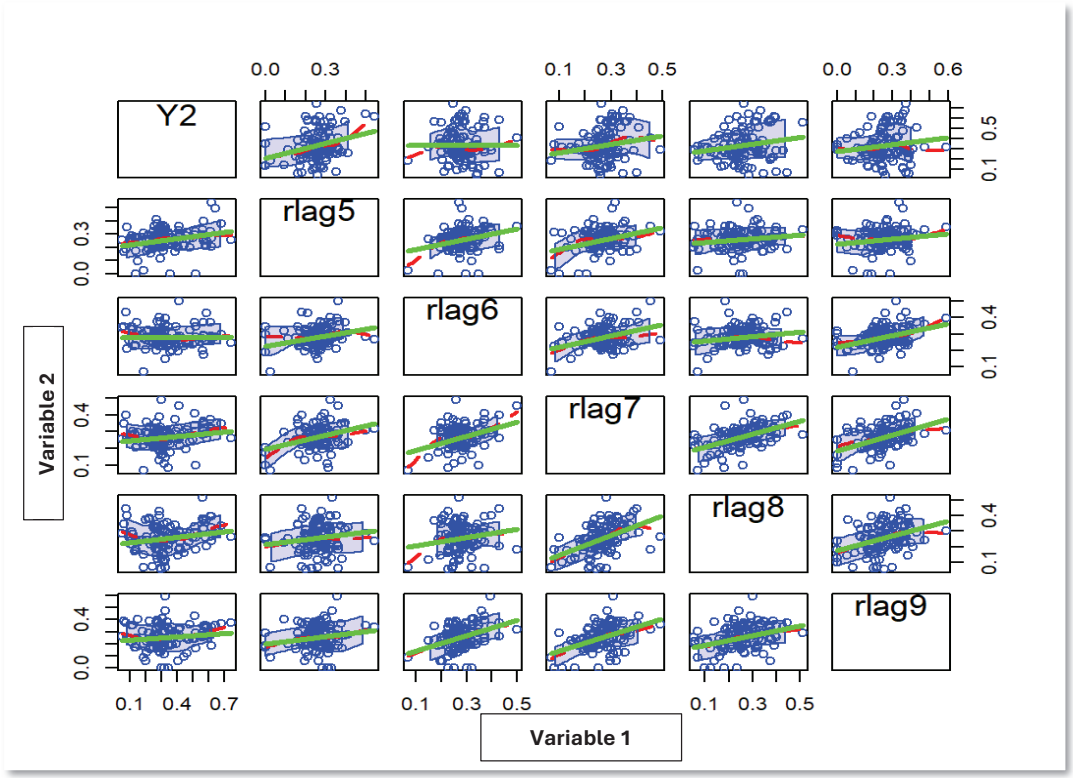
e. Scatterplot between the paddy productivity and lags ten to lag twelve Band 4 values



f. Scatterplot between the paddy productivity, current Band 8, and lag one to lag four Band 8 values



g. Scatterplot between the paddy productivity and lags five to lag nine Band 8 values



h. Scatterplot between the paddy productivity and lags ten to lag twelve Band 8 values