faoswsSeed: A package for the imputation of the seed domain of the Statistical Working System

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Abstract

This vignette provides detailed description of the usage of functions in the **faoswsSeed** package.

There are two sections to this paper. The first is introductory, and provides a breif overview of the algorithm followed by this package. The second section shows a sample execution of the module, and describes what each function is doing as execution proceeds.

Keywords: Seed, Agriculture.

1. Introduction

This algorithm follows this general process:

1. Pull agricultural data from the database.

2. Estimate the area sown for each year.

3. Estimate the seed rate.

4. Estimate the total seed used by multiplying the area sown by the seed rate.

5. Push the updated data.table back to the database.

2. Example

Before we begin, we will need to load the required library

```
> ## Load libraries
> library(faosws)
> library(faoswsSeed)
> library(faoswsImputation)
> library(faoswsUtil)
> library(data.table)
> library(ggplot2)
> library(faoswsProcessing)
>
```

2.1. Pull Data

Now, we need to get a data.table object from the working system. To do this, we'll need a token for the R session. To get this token, you'll need to create an .xml file that references the appropriate dataset: see the .xml file in the sws_seed repository. Alternatively, you can create an .xml file with the Code tag set to agriculture and four SelectableDimension's: geographicAreaM49, measuredItemCPC, measuredElement, timePointYears. Once you get this token, you can run GetTestEnvironment (see below, baseUrl is the same) to load some variables (usually starting with swsContext.*) into your workspace.

Now, we may change the dataset of interest by updating the keys in the *swsContext.datasets[[1]]* object. For example, let's look at Austria's data (geographicAreaM49 code of "40"). Note: multiple keys are allowed.

Lastly, the getAreaData function will pull in the seed data needed. The code below shows an example of what these calls look like, although it is not executable as the token is no longer valid.

```
> ## Pull in necessary swsContext parameters, see faosws documentation
> GetTestEnvironment(
+     baseUrl = "https://hqlqasws1.hq.un.fao.org:8181/sws",
+     token = "ec5a4b0e-0ffa-432e-9db0-ba08072c924b"
+ )
> swsContext.datasets[[1]]@dimensions$geographicAreaM49@keys = c("40")
> data = getAreaData(dataContext = swsContext.datasets[[1]],
+                    areaSownElementCode = "5212",
+                    areaHarvestedElementCode = "5312",
+                    seedElementCode = "5525")
```

We can't pull this data directly, but the faoswsSeed package has a default dataset that would result from this kind of a call:

```
> head(seedData)
```

```
   geographicAreaM49 measuredItemCPC timePointYears Value_measuredElement_5212
1:               100            0111           1994                          NA
2:               100            0111           1995                          NA
3:               100            0111           1996                          NA
4:               100            0111           1997                          NA
5:               100            0111           1998                          NA
6:               100            0111           1999                          NA
   flagObservationStatus_measuredElement_5212 flagMethod_measuredElement_5212
1:                                          M                               u
2:                                          M                               u
3:                                          M                               u
4:                                          M                               u
5:                                          M                               u
6:                                          M                               u
   Value_measuredElement_5312 flagObservationStatus_measuredElement_5312
1:                    1319760
2:                    1181120
3:                     957670
4:                    1211720
```

```
5:                            1141682
6:                             966282
   flagMethod_measuredElement_5312 Value_measuredElement_5525
1:                               -                            NA
2:                               -                            NA
3:                               -                            NA
4:                               -                            NA
5:                               -                            NA
6:                               -                            NA
   flagObservationStatus_measuredElement_5525 flagMethod_measuredElement_5525
1:                                          M                               u
2:                                          M                               u
3:                                          M                               u
4:                                          M                               u
5:                                          M                               u
6:                                          M                               u
```

The data is somewhat cryptic, as there are alot of codes used, but it's there.

2.2. Estimate Area Sown

Next, we need to impute the missing values. Imputation follows one of several methods:

1. If no area sown values exist, the area sown is imputed as the area harvested.

2. If some area sown values exist, then imputation is performed based on input parameters. If the imputationParameters argument is NULL, then an average ratio is computed across all non-missing values within each byKey group (by default, byKey is NULL and so the ratio is computed with all the data): $R =$(area sown) / (area harvested). Missing values for area sown are then imputed by taking the area harvested and multiplying by this ratio.

3. If some area sown values exist and imputationParameters is not NULL, then imputation is performed via ensemble imputation from the faoswsImputation package. All of the elegant models in that framework are not likely to be useful here, as most countries have no data. However, two models such as a local and global mean may be helpful.

In this example, we have the first scenario (remember, 5212 is the area sown code and 5312 is the area harvested).

```
     time areaSown areaHarvested
 1: 1994   131916        101212
 2: 1995   131334        100108
 3: 1996   130934         99660
 4: 1997   130874         98901
 5: 1998   129658         99099
 6: 1999   127066         99000
 7: 2000   106000         88672
 8: 2001    93000         82186
 9: 2002    93000         82846
10: 2003    93100         93032
11: 2004    93000         93217
12: 2005   100000         86028
```

```
13: 2006   80000          75634
14: 2007   80000          75260
15: 2008   83000          75776
16: 2009   83000          75933
17: 2010      NA          73922
18: 2011   83000          75511
19: 2012      NA             NA
20: 2013      NA             NA
```

```
    geographicAreaM49 measuredItemCPC timePointYears
  1:              100            0111          1994
  2:              100            0111          1995
  3:              100            0111          1996
  4:              100            0111          1997
  5:              100            0111          1998
 ---
8956:             348         26190.01          2009
8957:             348         26190.01          2010
8958:             348         26190.01          2011
8959:             348         26190.01          2012
8960:             348         26190.01          2013
    Value_measuredElement_5212 flagObservationStatus_measuredElement_5212
  1:                 1330631.1                                          I
  2:                 1190849.1                                          I
  3:                  965558.5                                          I
  4:                 1221701.2                                          I
  5:                 1151086.2                                          I
 ---
8956:                       NA                                          M
8957:                       NA                                          M
8958:                       NA                                          M
8959:                       NA                                          M
8960:                       NA                                          M
    flagMethod_measuredElement_5212 Value_measuredElement_5312
  1:                               e                    1319760
  2:                               e                    1181120
  3:                               e                     957670
  4:                               e                    1211720
  5:                               e                    1141682
 ---
8956:                              e                         NA
8957:                              e                         NA
8958:                              e                         NA
8959:                              e                         NA
8960:                              e                         NA
    flagObservationStatus_measuredElement_5312
  1:
  2:
  3:
  4:
  5:
 ---
```

```
8956:                                           M
8957:                                           M
8958:                                           M
8959:                                           M
8960:                                           M
      flagMethod_measuredElement_5312 Value_measuredElement_5525
  1:                                -                          NA
  2:                                -                          NA
  3:                                -                          NA
  4:                                -                          NA
  5:                                -                          NA
 ---
8956:                                u                          NA
8957:                                u                          NA
8958:                                u                          NA
8959:                                u                          NA
8960:                                u                          NA
      flagObservationStatus_measuredElement_5525
  1:                                          M
  2:                                          M
  3:                                          M
  4:                                          M
  5:                                          M
 ---
8956:                                          M
8957:                                          M
8958:                                          M
8959:                                          M
8960:                                          M
      flagMethod_measuredElement_5525 Value_areaSownRatio
  1:                                u            1.008237
  2:                                u            1.008237
  3:                                u            1.008237
  4:                                u            1.008237
  5:                                u            1.008237
 ---
8956:                                u            1.008237
8957:                                u            1.008237
8958:                                u            1.008237
8959:                                u            1.008237
8960:                                u            1.008237
      flagObservationStatus_areaSownRatio flagMethod_areaSownRatio
  1:                                    I                        e
  2:                                    I                        e
  3:                                    I                        e
  4:                                    I                        e
  5:                                    I                        e
 ---
8956:                                    I                        e
8957:                                    I                        e
8958:                                    I                        e
```

8959:		I	e
8960:		I	e

	time	areaSown	areaHarvested	Value_areaSownRatio
1:	1994	131916.00	101212	1.008237
2:	1995	131334.00	100108	1.008237
3:	1996	130934.00	99660	1.008237
4:	1997	130874.00	98901	1.008237
5:	1998	129658.00	99099	1.008237
6:	1999	127066.00	99000	1.008237
7:	2000	106000.00	88672	1.008237
8:	2001	93000.00	82186	1.008237
9:	2002	93000.00	82846	1.008237
10:	2003	93100.00	93032	1.008237
11:	2004	93000.00	93217	1.008237
12:	2005	100000.00	86028	1.008237
13:	2006	80000.00	75634	1.008237
14:	2007	80000.00	75260	1.008237
15:	2008	83000.00	75776	1.008237
16:	2009	83000.00	75933	1.008237
17:	2010	74530.91	73922	1.008237
18:	2011	83000.00	75511	1.008237
19:	2012	NA	NA	1.008237
20:	2013	NA	NA	1.008237

The areaSownRatio is estimated globally by default. We could also estimate the ratio within each country and commodity individually:

```
> temp = copy(seedData)
> imputeAreaSown(data = temp, codeAreaSown = "5212",
+               byKey = c("geographicAreaM49", "measuredItemCPC"))
```

	geographicAreaM49	measuredItemCPC	timePointYears
1:	100	0111	1994
2:	100	0111	1995
3:	100	0111	1996
4:	100	0111	1997
5:	100	0111	1998

8956:	348	26190.01	2009
8957:	348	26190.01	2010
8958:	348	26190.01	2011
8959:	348	26190.01	2012
8960:	348	26190.01	2013

	Value_measuredElement_5212	flagObservationStatus_measuredElement_5212
1:	1319760	
2:	1181120	
3:	957670	
4:	1211720	
5:	1141682	

```
8956:                               NA                                                M
8957:                               NA                                                M
8958:                               NA                                                M
8959:                               NA                                                M
8960:                               NA                                                M
      flagMethod_measuredElement_5212 Value_measuredElement_5312
   1:                               e                                   1319760
   2:                               e                                   1181120
   3:                               e                                    957670
   4:                               e                                   1211720
   5:                               e                                   1141682
  ---
8956:                               e                                        NA
8957:                               e                                        NA
8958:                               e                                        NA
8959:                               e                                        NA
8960:                               e                                        NA
      flagObservationStatus_measuredElement_5312
   1:
   2:
   3:
   4:
   5:
  ---
8956:                                        M
8957:                                        M
8958:                                        M
8959:                                        M
8960:                                        M
      flagMethod_measuredElement_5312 Value_measuredElement_5525
   1:                               -                                        NA
   2:                               -                                        NA
   3:                               -                                        NA
   4:                               -                                        NA
   5:                               -                                        NA
  ---
8956:                               u                                        NA
8957:                               u                                        NA
8958:                               u                                        NA
8959:                               u                                        NA
8960:                               u                                        NA
      flagObservationStatus_measuredElement_5525
   1:                                        M
   2:                                        M
   3:                                        M
   4:                                        M
   5:                                        M
  ---
8956:                                        M
8957:                                        M
8958:                                        M
```

```
8959:                                        M
8960:                                        M
     flagMethod_measuredElement_5525 Value_areaSownRatio
  1:                              u              NaN
  2:                              u              NaN
  3:                              u              NaN
  4:                              u              NaN
  5:                              u              NaN
 ---
8956:                            u              NaN
8957:                            u              NaN
8958:                            u              NaN
8959:                            u              NaN
8960:                            u              NaN
     flagObservationStatus_areaSownRatio flagMethod_areaSownRatio
  1:                                I                          e
  2:                                I                          e
  3:                                I                          e
  4:                                I                          e
  5:                                I                          e
 ---
8956:                              I                          e
8957:                              I                          e
8958:                              I                          e
8959:                              I                          e
8960:                              I                          e

> temp[geographicAreaM49 == 348 & measuredItemCPC == "01330",
+     .(time = timePointYears, areaSown = Value_measuredElement_5212,
+       areaHarvested = Value_measuredElement_5312, Value_areaSownRatio)]

    time  areaSown areaHarvested Value_areaSownRatio
 1: 1994 131916.00       101212           1.168406
 2: 1995 131334.00       100108           1.168406
 3: 1996 130934.00        99660           1.168406
 4: 1997 130874.00        98901           1.168406
 5: 1998 129658.00        99099           1.168406
 6: 1999 127066.00        99000           1.168406
 7: 2000 106000.00        88672           1.168406
 8: 2001  93000.00        82186           1.168406
 9: 2002  93000.00        82846           1.168406
10: 2003  93100.00        93032           1.168406
11: 2004  93000.00        93217           1.168406
12: 2005 100000.00        86028           1.168406
13: 2006  80000.00        75634           1.168406
14: 2007  80000.00        75260           1.168406
15: 2008  83000.00        75776           1.168406
16: 2009  83000.00        75933           1.168406
17: 2010  86370.91        73922           1.168406
18: 2011  83000.00        75511           1.168406
19: 2012        NA           NA           1.168406
20: 2013        NA           NA           1.168406
```

Or, we can estimate the ratio via an ensemble method (from faoswsImputation):

```
> imputationParams = defaultImputationParameters(variable = "seed")
> ## Coerce type to character instead of default factor type
> imputationParams$flagTable$flagObservationStatus =
+     as.character(imputationParams$flagTable$flagObservationStatus)
> imputationParams$ensembleModels = list(
+     defaultMean = ensembleModel(model = defaultMean, extrapolationRange = Inf,
+                         level = "local"),
+     globalMean = ensembleModel(model = defaultGlobalMean,
+                         extrapolationRange = Inf, level = "global"),
+     defaultLm = ensembleModel(model = defaultLm, extrapolationRange = Inf,
+                         level = "local"))
> temp = seedData[measuredItemCPC == "01330", ]
> imputeAreaSown(data = temp, codeAreaSown = "5212",
+             imputationParameters = imputationParams)
```

```
    geographicAreaM49 measuredItemCPC timePointYears
 1:               100          01330           1994
 2:               100          01330           1995
 3:               100          01330           1996
 4:               100          01330           1997
 5:               100          01330           1998
 6:               100          01330           1999
 7:               100          01330           2000
 8:               100          01330           2001
 9:               100          01330           2002
10:               100          01330           2003
11:               100          01330           2004
12:               100          01330           2005
13:               100          01330           2006
14:               100          01330           2007
15:               100          01330           2008
16:               100          01330           2009
17:               100          01330           2010
18:               100          01330           2011
19:               100          01330           2012
20:               100          01330           2013
21:               348          01330           1994
22:               348          01330           1995
23:               348          01330           1996
24:               348          01330           1997
25:               348          01330           1998
26:               348          01330           1999
27:               348          01330           2000
28:               348          01330           2001
29:               348          01330           2002
30:               348          01330           2003
31:               348          01330           2004
32:               348          01330           2005
33:               348          01330           2006
34:               348          01330           2007
```

35:	348	01330	2008
36:	348	01330	2009
37:	348	01330	2010
38:	348	01330	2011
39:	348	01330	2012
40:	348	01330	2013
41:	400	01330	1994
42:	400	01330	1995
43:	400	01330	1996
44:	400	01330	1997
45:	400	01330	1998
46:	400	01330	1999
47:	400	01330	2000
48:	400	01330	2001
49:	400	01330	2002
50:	400	01330	2003
51:	400	01330	2004
52:	400	01330	2005
53:	400	01330	2006
54:	400	01330	2007
55:	400	01330	2008
56:	400	01330	2009
57:	400	01330	2010
58:	400	01330	2011
59:	400	01330	2012
60:	400	01330	2013
61:	638	01330	1994
62:	638	01330	1995
63:	638	01330	1996
64:	638	01330	1997
65:	638	01330	1998
66:	638	01330	1999
67:	638	01330	2000
68:	638	01330	2001
69:	638	01330	2002
70:	638	01330	2003
71:	638	01330	2004
72:	638	01330	2005
73:	638	01330	2006
74:	638	01330	2007
75:	638	01330	2008
76:	638	01330	2009
77:	638	01330	2010
78:	638	01330	2011
79:	638	01330	2012
80:	638	01330	2013
81:	804	01330	1994
82:	804	01330	1995
83:	804	01330	1996
84:	804	01330	1997
85:	804	01330	1998

86:	804	01330	1999
87:	804	01330	2000
88:	804	01330	2001
89:	804	01330	2002
90:	804	01330	2003
91:	804	01330	2004
92:	804	01330	2005
93:	804	01330	2006
94:	804	01330	2007
95:	804	01330	2008
96:	804	01330	2009
97:	804	01330	2010
98:	804	01330	2011
99:	804	01330	2012
100:	804	01330	2013

```
    geographicAreaM49 measuredItemCPC timePointYears
    Value_measuredElement_5212 flagObservationStatus_measuredElement_5212
```

	Value_measuredElement_5212	flagObservationStatus_measuredElement_5212
1:	133408.46265	I
2:	131806.80738	I
3:	126013.76158	I
4:	125894.81513	I
5:	132381.51898	I
6:	130223.99511	I
7:	130967.11605	I
8:	151588.42768	I
9:	134998.34105	I
10:	154358.34915	I
11:	152519.97865	I
12:	149380.26324	I
13:	151753.30395	I
14:	141724.11550	I
15:	130506.64016	I
16:	119457.57416	I
17:	97365.33059	I
18:	92410.79844	I
19:	NA	M
20:	NA	M
21:	131916.00000	
22:	131334.00000	
23:	130934.00000	
24:	130874.00000	
25:	129658.00000	
26:	127066.00000	
27:	106000.00000	
28:	93000.00000	
29:	93000.00000	
30:	93100.00000	
31:	93000.00000	
32:	100000.00000	E
33:	80000.00000	E
34:	80000.00000	E

35:	83000.00000	
36:	83000.00000	
37:	81618.23183	I
38:	83000.00000	E
39:	NA	M
40:	NA	M
41:	2356.00000	
42:	2385.00000	
43:	2424.00000	
44:	3684.00000	
45:	3705.00000	
46:	3709.00000	
47:	3739.00000	
48:	3771.00000	
49:	3904.00000	
50:	3630.00000	
51:	3635.00000	
52:	3635.00000	
53:	3646.00000	
54:	3089.00000	
55:	3110.00000	
56:	3138.00000	
57:	3199.00000	
58:	3941.00000	
59:	NA	M
60:	NA	M
61:	23.55375	I
62:	23.55375	I
63:	23.55375	I
64:	27.08682	I
65:	29.44219	I
66:	28.26450	I
67:	29.44219	I
68:	30.61988	I
69:	31.79757	I
70:	32.97526	I
71:	23.55375	I
72:	23.55375	I
73:	34.15294	I
74:	23.55375	I
75:	NA	M
76:	24.73144	I
77:	35.33063	I
78:	36.50832	I
79:	NA	M
80:	NA	M
81:	160100.00000	
82:	155000.00000	
83:	148200.00000	
84:	138600.00000	
85:	126000.00000	

```
 86:         116000.00000
 87:         110000.00000
 88:         105000.00000
 89:         103000.00000
 90:          99000.00000
 91:          97000.00000
 92:          96000.00000
 93:          93000.00000
 94:          93000.00000
 95:          93000.00000                                      T
 96:          93000.00000                                      T
 97:          88000.00000                                      T
 98:          90200.00000                                      T
 99:                  NA                                      M
100:                  NA                                      M
```

	Value_measuredElement_5212	flagObservationStatus_measuredElement_5212 flagMethod_measuredElement_5212	Value_measuredElement_5312
1:		e	113280
2:		e	111920
3:		e	107001
4:		e	106900
5:		e	112408
6:		e	110576
7:		e	111207
8:		e	128717
9:		e	114630
10:		e	131069
11:		e	129508
12:		e	126842
13:		e	128857
14:		e	120341
15:		e	110816
16:		e	101434
17:		e	82675
18:		e	78468
19:		e	NA
20:		e	NA
21:		–	101212
22:		–	100108
23:		–	99660
24:		–	98901
25:		–	99099
26:		–	99000
27:		–	88672
28:		–	82186
29:		–	82846
30:		–	93032
31:		–	93217
32:		f	86028
33:		f	75634
34:		f	75260

35:	–	75776
36:	–	75933
37:	e	73922
38:	f	75511
39:	e	NA
40:	e	NA
41:	e	2356
42:	e	2385
43:	e	2424
44:	e	3684
45:	e	3705
46:	e	3709
47:	e	3739
48:	e	3771
49:	e	3904
50:	e	3630
51:	e	3635
52:	e	3635
53:	e	3646
54:	e	3089
55:	e	3110
56:	e	3138
57:	e	3199
58:	e	3941
59:	e	NA
60:	e	NA
61:	e	20
62:	e	20
63:	e	20
64:	e	23
65:	e	25
66:	e	24
67:	e	25
68:	e	26
69:	e	27
70:	e	28
71:	e	20
72:	e	20
73:	e	29
74:	e	20
75:	e	NA
76:	e	21
77:	e	30
78:	e	31
79:	e	NA
80:	e	NA
81:	–	140000
82:	–	137700
83:	–	134323
84:	–	122900
85:	–	112300

	flagMethod_measuredElement_5212	Value_measuredElement_5312
86:	–	104800
87:	–	99400
88:	–	94700
89:	–	91200
90:	–	85500
91:	–	82800
92:	–	80600
93:	–	75800
94:	–	71200
95:	p	70900
96:	p	71000
97:	p	67600
98:	p	69100
99:	e	NA
100:	e	NA

	flagObservationStatus_measuredElement_5312	flagMethod_measuredElement_5312
1:		–
2:		–
3:		–
4:		–
5:		–
6:		–
7:		–
8:		–
9:		–
10:		–
11:		–
12:		–
13:		–
14:		–
15:		–
16:		–
17:		–
18:		–
19:	M	u
20:	M	u
21:		–
22:		–
23:		–
24:		–
25:		–
26:		–
27:		–
28:		–
29:		–
30:		–
31:		–
32:		–
33:		–
34:		–

```
35:                                                         –
36:                                                         –
37:                                                         –
38:                                                         –
39:                              M                          u
40:                              M                          u
41:                                                         –
42:                                                         –
43:                                                         –
44:                                                         –
45:                                                         –
46:                                                         –
47:                                                         –
48:                                                         –
49:                                                         –
50:                                                         –
51:                                                         –
52:                                                         –
53:                                                         –
54:                                                         –
55:                                                         –
56:                                                         –
57:                                                         –
58:                                                         –
59:                              M                          u
60:                              M                          u
61:                              E                          f
62:                              E                          f
63:                              E                          f
64:                              E                          e
65:                              E                          e
66:                              E                          e
67:                              E                          e
68:                              E                          e
69:                              E                          e
70:                              E                          e
71:                              E                          f
72:                              E                          f
73:                              E                          e
74:                              E                          f
75:                              M                          u
76:                              E                          e
77:                              E                          f
78:                              E                          e
79:                              M                          u
80:                              M                          u
81:                                                         –
82:                                                         –
83:                                                         –
84:                                                         –
85:                                                         –
```

```
 86:                                                                        -
 87:                                                                        -
 88:                                                                        -
 89:                                                                        -
 90:                                                                        -
 91:                                                                        -
 92:                                                                        -
 93:                                                                        -
 94:                                                                        -
 95:                                                                        -
 96:                                                                        -
 97:                                                                        -
 98:                                                                        -
 99:                                             M                          u
100:                                             M                          u
```

flagObservationStatus_measuredElement_5312 flagMethod_measuredElement_5312
Value_measuredElement_5525 flagObservationStatus_measuredElement_5525

```
  1:                         NA                                      M
  2:                         NA                                      M
  3:                         NA                                      M
  4:                         NA                                      M
  5:                         NA                                      M
  6:                         NA                                      M
  7:                         NA                                      M
  8:                         NA                                      M
  9:                         NA                                      M
 10:                         NA                                      M
 11:                         NA                                      M
 12:                         NA                                      M
 13:                         NA                                      M
 14:                         NA                                      M
 15:                         NA                                      M
 16:                         NA                                      M
 17:                         NA                                      M
 18:                         NA                                      M
 19:                         NA                                      M
 20:                         NA                                      M
 21:                         NA                                      M
 22:                         NA                                      M
 23:                         NA                                      M
 24:                         NA                                      M
 25:                         NA                                      M
 26:                         NA                                      M
 27:                         NA                                      M
 28:                         NA                                      M
 29:                         NA                                      M
 30:                         NA                                      M
 31:                         NA                                      M
 32:                         NA                                      M
 33:                         NA                                      M
 34:                         NA                                      M
```

35:	NA	M
36:	NA	M
37:	NA	M
38:	NA	M
39:	NA	M
40:	NA	M
41:	NA	M
42:	NA	M
43:	NA	M
44:	NA	M
45:	NA	M
46:	NA	M
47:	NA	M
48:	NA	M
49:	NA	M
50:	NA	M
51:	NA	M
52:	NA	M
53:	NA	M
54:	NA	M
55:	NA	M
56:	NA	M
57:	NA	M
58:	NA	M
59:	NA	M
60:	NA	M
61:	NA	M
62:	NA	M
63:	NA	M
64:	NA	M
65:	NA	M
66:	NA	M
67:	NA	M
68:	NA	M
69:	NA	M
70:	NA	M
71:	NA	M
72:	NA	M
73:	NA	M
74:	NA	M
75:	NA	M
76:	NA	M
77:	NA	M
78:	NA	M
79:	NA	M
80:	NA	M
81:	NA	M
82:	NA	M
83:	NA	M
84:	NA	M
85:	NA	M

```
 86:                        NA                                    M
 87:                        NA                                    M
 88:                        NA                                    M
 89:                        NA                                    M
 90:                        NA                                    M
 91:                        NA                                    M
 92:                        NA                                    M
 93:                        NA                                    M
 94:                        NA                                    M
 95:                        NA                                    M
 96:                        NA                                    M
 97:                        NA                                    M
 98:                        NA                                    M
 99:                        NA                                    M
100:                        NA                                    M
     Value_measuredElement_5525 flagObservationStatus_measuredElement_5525
     flagMethod_measuredElement_5525 Value_areaSownRatio
  1:                              u                 1.177688
  2:                              u                 1.177688
  3:                              u                 1.177688
  4:                              u                 1.177688
  5:                              u                 1.177688
  6:                              u                 1.177688
  7:                              u                 1.177688
  8:                              u                 1.177688
  9:                              u                 1.177688
 10:                              u                 1.177688
 11:                              u                 1.177688
 12:                              u                 1.177688
 13:                              u                 1.177688
 14:                              u                 1.177688
 15:                              u                 1.177688
 16:                              u                 1.177688
 17:                              u                 1.177688
 18:                              u                 1.177688
 19:                              u                 1.177688
 20:                              u                 1.177688
 21:                              u                 1.303363
 22:                              u                 1.311923
 23:                              u                 1.313807
 24:                              u                 1.323283
 25:                              u                 1.308368
 26:                              u                 1.283495
 27:                              u                 1.195417
 28:                              u                 1.131580
 29:                              u                 1.122565
 30:                              u                 1.000731
 31:                              u                 1.000000
 32:                              u                 1.162412
 33:                              u                 1.057725
 34:                              u                 1.062982
```

35:	u	1.095334
36:	u	1.093069
37:	u	1.104113
38:	u	1.099178
39:	u	1.087283
40:	u	1.078869
41:	u	NA
42:	u	NA
43:	u	NA
44:	u	NA
45:	u	NA
46:	u	NA
47:	u	NA
48:	u	NA
49:	u	NA
50:	u	NA
51:	u	NA
52:	u	NA
53:	u	NA
54:	u	NA
55:	u	NA
56:	u	NA
57:	u	NA
58:	u	NA
59:	u	NA
60:	u	NA
61:	u	1.177688
62:	u	1.177688
63:	u	1.177688
64:	u	1.177688
65:	u	1.177688
66:	u	1.177688
67:	u	1.177688
68:	u	1.177688
69:	u	1.177688
70:	u	1.177688
71:	u	1.177688
72:	u	1.177688
73:	u	1.177688
74:	u	1.177688
75:	u	1.177688
76:	u	1.177688
77:	u	1.177688
78:	u	1.177688
79:	u	1.177688
80:	u	1.177688
81:	u	1.143571
82:	u	1.125635
83:	u	1.103311
84:	u	1.127746
85:	u	1.121995

```
 86:                              u          1.106870
 87:                              u          1.106640
 88:                              u          1.108765
 89:                              u          1.129386
 90:                              u          1.157895
 91:                              u          1.171498
 92:                              u          1.191067
 93:                              u          1.226913
 94:                              u          1.306180
 95:                              u          1.311707
 96:                              u          1.309859
 97:                              u          1.301775
 98:                              u          1.305355
 99:                              u          1.246365
100:                              u          1.252916
    flagMethod_measuredElement_5525 Value_areaSownRatio
    flagObservationStatus_areaSownRatio flagMethod_areaSownRatio
  1:                              M                          e
  2:                              M                          e
  3:                              M                          e
  4:                              M                          e
  5:                              M                          e
  6:                              M                          e
  7:                              M                          e
  8:                              M                          e
  9:                              M                          e
 10:                              M                          e
 11:                              M                          e
 12:                              M                          e
 13:                              M                          e
 14:                              M                          e
 15:                              M                          e
 16:                              M                          e
 17:                              M                          e
 18:                              M                          e
 19:                              M                          e
 20:                              M                          e
 21:                                                         e
 22:                                                         e
 23:                                                         e
 24:                                                         e
 25:                                                         e
 26:                                                         e
 27:                                                         e
 28:                                                         e
 29:                                                         e
 30:                                                         e
 31:                                                         e
 32:                              E                          e
 33:                              E                          e
 34:                              E                          e
```

```
35:                               e
36:                               e
37:              M                e
38:              E                e
39:              M                e
40:              M                e
41:              M                e
42:              M                e
43:              M                e
44:              M                e
45:              M                e
46:              M                e
47:              M                e
48:              M                e
49:              M                e
50:              M                e
51:              M                e
52:              M                e
53:              M                e
54:              M                e
55:              M                e
56:              M                e
57:              M                e
58:              M                e
59:              M                e
60:              M                e
61:              M                e
62:              M                e
63:              M                e
64:              M                e
65:              M                e
66:              M                e
67:              M                e
68:              M                e
69:              M                e
70:              M                e
71:              M                e
72:              M                e
73:              M                e
74:              M                e
75:              M                e
76:              M                e
77:              M                e
78:              M                e
79:              M                e
80:              M                e
81:                               e
82:                               e
83:                               e
84:                               e
85:                               e
```

```
 86:                                                                   e
 87:                                                                   e
 88:                                                                   e
 89:                                                                   e
 90:                                                                   e
 91:                                                                   e
 92:                                                                   e
 93:                                                                   e
 94:                                                                   e
 95:                                           T                       e
 96:                                           T                       e
 97:                                           T                       e
 98:                                           T                       e
 99:                                           M                       e
100:                                           M                       e
     flagObservationStatus_areaSownRatio flagMethod_areaSownRatio

> temp[geographicAreaM49 == 348 & measuredItemCPC == "01330",
+     .(time = timePointYears, areaSown = Value_measuredElement_5212,
+       areaHarvested = Value_measuredElement_5312, Value_areaSownRatio)]

    time   areaSown areaHarvested Value_areaSownRatio
 1: 1994 131916.00        101212           1.303363
 2: 1995 131334.00        100108           1.311923
 3: 1996 130934.00         99660           1.313807
 4: 1997 130874.00         98901           1.323283
 5: 1998 129658.00         99099           1.308368
 6: 1999 127066.00         99000           1.283495
 7: 2000 106000.00         88672           1.195417
 8: 2001  93000.00         82186           1.131580
 9: 2002  93000.00         82846           1.122565
10: 2003  93100.00         93032           1.000731
11: 2004  93000.00         93217           1.000000
12: 2005 100000.00         86028           1.162412
13: 2006  80000.00         75634           1.057725
14: 2007  80000.00         75260           1.062982
15: 2008  83000.00         75776           1.095334
16: 2009  83000.00         75933           1.093069
17: 2010  81618.23         73922           1.104113
18: 2011  83000.00         75511           1.099178
19: 2012        NA            NA           1.087283
20: 2013        NA            NA           1.078869
```

In this example, notice that we filtered the seedData set to one specific measuredItemCPC code. This is a requirement for imputeAreaSown: it can only handle one CPC code at a time. A future goal of this package is to add an additional function that calls imputeAreaSown for each individual CPC code.

Additionally, note that the defaultLm model could be problematic: predictions in the later years for the left graph give ratios of less than 1. These don't make sense: you can't sow less area than your harvest. There is a check within the code that corrects any imputed values less than 1 (by setting it to 1); however, the analyst should ensure that the models they use do not impute values smaller than 1 as a good practice.

Note that this ensemble model seems to generate improved estimates of area sown rates in this scenario. However, in most scenarios, area sown is not available. Moreover, if it is, it is generally available for almost all years. The usual scenario would be more like the following example:

```
> data = seedData[measuredItemCPC == "0111", ]
> data[geographicAreaM49 == 100,
+       .(time = timePointYears, areaSown = Value_measuredElement_5212,
+         areaHarvested = Value_measuredElement_5312)]
```

```
    time areaSown areaHarvested
 1: 1994      NA       1319760
 2: 1995      NA       1181120
 3: 1996      NA        957670
 4: 1997      NA       1211720
 5: 1998      NA       1141682
 6: 1999      NA        966282
 7: 2000      NA        978575
 8: 2001      NA       1355500
 9: 2002      NA       1368627
10: 2003      NA        841014
11: 2004      NA       1039680
12: 2005      NA       1101807
13: 2006      NA        970392
14: 2007      NA       1087996
15: 2008      NA       1111533
16: 2009      NA       1247718
17: 2010      NA       1137650
18: 2011      NA       1137642
19: 2012      NA       1090000
20: 2013      NA            NA
```

```
> imputeAreaSown(data = data, codeAreaSown = "5212",
+                imputationParameters = imputationParams)
```

```
    geographicAreaM49 measuredItemCPC timePointYears
 1:               100            0111           1994
 2:               100            0111           1995
 3:               100            0111           1996
 4:               100            0111           1997
 5:               100            0111           1998
 6:               100            0111           1999
 7:               100            0111           2000
 8:               100            0111           2001
 9:               100            0111           2002
10:               100            0111           2003
11:               100            0111           2004
12:               100            0111           2005
13:               100            0111           2006
14:               100            0111           2007
15:               100            0111           2008
```

16:	100	0111	2009
17:	100	0111	2010
18:	100	0111	2011
19:	100	0111	2012
20:	100	0111	2013
21:	894	0111	1994
22:	894	0111	1995
23:	894	0111	1996
24:	894	0111	1997
25:	894	0111	1998
26:	894	0111	1999
27:	894	0111	2000
28:	894	0111	2001
29:	894	0111	2002
30:	894	0111	2003
31:	894	0111	2004
32:	894	0111	2005
33:	894	0111	2006
34:	894	0111	2007
35:	894	0111	2008
36:	894	0111	2009
37:	894	0111	2010
38:	894	0111	2011
39:	894	0111	2012
40:	894	0111	2013
41:	804	0111	1994
42:	804	0111	1995
43:	804	0111	1996
44:	804	0111	1997
45:	804	0111	1998
46:	804	0111	1999
47:	804	0111	2000
48:	804	0111	2001
49:	804	0111	2002
50:	804	0111	2003
51:	804	0111	2004
52:	804	0111	2005
53:	804	0111	2006
54:	804	0111	2007
55:	804	0111	2008
56:	804	0111	2009
57:	804	0111	2010
58:	804	0111	2011
59:	804	0111	2012
60:	804	0111	2013
61:	400	0111	1994
62:	400	0111	1995
63:	400	0111	1996
64:	400	0111	1997
65:	400	0111	1998
66:	400	0111	1999

67:	400	0111	2000
68:	400	0111	2001
69:	400	0111	2002
70:	400	0111	2003
71:	400	0111	2004
72:	400	0111	2005
73:	400	0111	2006
74:	400	0111	2007
75:	400	0111	2008
76:	400	0111	2009
77:	400	0111	2010
78:	400	0111	2011
79:	400	0111	2012
80:	400	0111	2013
81:	348	0111	1994
82:	348	0111	1995
83:	348	0111	1996
84:	348	0111	1997
85:	348	0111	1998
86:	348	0111	1999
87:	348	0111	2000
88:	348	0111	2001
89:	348	0111	2002
90:	348	0111	2003
91:	348	0111	2004
92:	348	0111	2005
93:	348	0111	2006
94:	348	0111	2007
95:	348	0111	2008
96:	348	0111	2009
97:	348	0111	2010
98:	348	0111	2011
99:	348	0111	2012
100:	348	0111	2013

```
    geographicAreaM49 measuredItemCPC timePointYears
    Value_measuredElement_5212 flagObservationStatus_measuredElement_5212
```

	Value_measuredElement_5212	flagObservationStatus_measuredElement_5212
1:	1319760	I
2:	1181120	I
3:	957670	I
4:	1211720	I
5:	1141682	I
6:	966282	I
7:	978575	I
8:	1355500	I
9:	1368627	I
10:	841014	I
11:	1039680	I
12:	1101807	I
13:	970392	I
14:	1087996	I
15:	1111533	I

```
16:          1247718                    I
17:          1137650                    I
18:          1137642                    I
19:          1090000                    I
20:               NA                    M
21:            11566                    I
22:             7806                    I
23:            10327                    I
24:            10693                    I
25:            11278                    I
26:             9921                    I
27:            12077                    I
28:            12000                    I
29:            12000                    I
30:            21000                    I
31:            13543                    I
32:            22033                    I
33:            17100                    I
34:            18833                    I
35:            11394                    I
36:            34296                    I
37:            27291                    I
38:            37631                    I
39:               NA                    M
40:               NA                    M
41:          4507000                    I
42:          5479400                    I
43:          5891800                    I
44:          6508400                    I
45:          5641000                    I
46:          5931600                    I
47:          5161600                    I
48:          6882000                    I
49:          6749600                    I
50:          2456400                    I
51:          5533700                    I
52:          6571000                    I
53:          5511000                    I
54:          5951300                    I
55:          7053600                    I
56:          6752900                    I
57:          6284100                    I
58:          6657300                    I
59:          6400000                    I
60:               NA                    M
61:            29715                    I
62:            40555                    I
63:            28349                    I
64:            37920                    I
65:            28835                    I
66:             4087                    I
```

```
 67:                        18204                                                      I
 68:                        13449                                                      I
 69:                        32745                                                      I
 70:                        29781                                                      I
 71:                        10728                                                      I
 72:                        29292                                                      I
 73:                        26920                                                      I
 74:                        20760                                                      I
 75:                        12456                                                      I
 76:                        15878                                                      I
 77:                        21466                                                      I
 78:                        14330                                                      I
 79:                           NA                                                      M
 80:                           NA                                                      M
 81:                      1058749                                                      I
 82:                      1108000                                                      I
 83:                      1193340                                                      I
 84:                      1247569                                                      I
 85:                      1183540                                                      I
 86:                       734100                                                      I
 87:                      1024430                                                      I
 88:                      1205610                                                      I
 89:                      1110471                                                      I
 90:                      1113755                                                      I
 91:                      1173800                                                      I
 92:                      1130719                                                      I
 93:                      1074735                                                      I
 94:                      1111269                                                      I
 95:                      1125629                                                      I
 96:                      1146456                                                      I
 97:                      1011182                                                      I
 98:                       978000                                                      I
 99:                      1080000                                                      I
100:                           NA                                                      M
     Value_measuredElement_5212 flagObservationStatus_measuredElement_5212
     flagMethod_measuredElement_5212 Value_measuredElement_5312
  1:                                                e                      1319760
  2:                                                e                      1181120
  3:                                                e                       957670
  4:                                                e                      1211720
  5:                                                e                      1141682
  6:                                                e                       966282
  7:                                                e                       978575
  8:                                                e                      1355500
  9:                                                e                      1368627
 10:                                                e                       841014
 11:                                                e                      1039680
 12:                                                e                      1101807
 13:                                                e                       970392
 14:                                                e                      1087996
 15:                                                e                      1111533
```

16:	e	1247718
17:	e	1137650
18:	e	1137642
19:	e	1090000
20:	e	NA
21:	e	11566
22:	e	7806
23:	e	10327
24:	e	10693
25:	e	11278
26:	e	9921
27:	e	12077
28:	e	12000
29:	e	12000
30:	e	21000
31:	e	13543
32:	e	22033
33:	e	17100
34:	e	18833
35:	e	11394
36:	e	34296
37:	e	27291
38:	e	37631
39:	e	NA
40:	e	NA
41:	e	4507000
42:	e	5479400
43:	e	5891800
44:	e	6508400
45:	e	5641000
46:	e	5931600
47:	e	5161600
48:	e	6882000
49:	e	6749600
50:	e	2456400
51:	e	5533700
52:	e	6571000
53:	e	5511000
54:	e	5951300
55:	e	7053600
56:	e	6752900
57:	e	6284100
58:	e	6657300
59:	e	6400000
60:	e	NA
61:	e	29715
62:	e	40555
63:	e	28349
64:	e	37920
65:	e	28835
66:	e	4087

```
 67:                                        e                 18204
 68:                                        e                 13449
 69:                                        e                 32745
 70:                                        e                 29781
 71:                                        e                 10728
 72:                                        e                 29292
 73:                                        e                 26920
 74:                                        e                 20760
 75:                                        e                 12456
 76:                                        e                 15878
 77:                                        e                 21466
 78:                                        e                 14330
 79:                                        e                    NA
 80:                                        e                    NA
 81:                                        e               1058749
 82:                                        e               1108000
 83:                                        e               1193340
 84:                                        e               1247569
 85:                                        e               1183540
 86:                                        e                734100
 87:                                        e               1024430
 88:                                        e               1205610
 89:                                        e               1110471
 90:                                        e               1113755
 91:                                        e               1173800
 92:                                        e               1130719
 93:                                        e               1074735
 94:                                        e               1111269
 95:                                        e               1125629
 96:                                        e               1146456
 97:                                        e               1011182
 98:                                        e                978000
 99:                                        e               1080000
100:                                        e                    NA
     flagMethod_measuredElement_5212 Value_measuredElement_5312
     flagObservationStatus_measuredElement_5312 flagMethod_measuredElement_5312
  1:                                                                          -
  2:                                                                          -
  3:                                                                          -
  4:                                                                          -
  5:                                                                          -
  6:                                                                          -
  7:                                                                          -
  8:                                                                          -
  9:                                                                          -
 10:                                                                          -
 11:                                                                          -
 12:                                                                          -
 13:                                                                          -
 14:                                                                          -
 15:                                                                          -
```

16:		–
17:		–
18:		–
19:	T	p
20:	M	u
21:		–
22:		–
23:		–
24:		–
25:		–
26:		–
27:		–
28:	T	p
29:	T	p
30:	E	f
31:	T	p
32:		–
33:	T	p
34:		–
35:		–
36:		–
37:		–
38:		–
39:	M	u
40:	M	u
41:		–
42:		–
43:		–
44:		–
45:		–
46:		–
47:		–
48:		–
49:		–
50:		–
51:		–
52:		–
53:		–
54:		–
55:		–
56:		–
57:		–
58:		–
59:	T	p
60:	M	u
61:		–
62:		–
63:		–
64:		–
65:		–
66:		–

```
 67:                                                                           -
 68:                                                                           -
 69:                                                                           -
 70:                                                                           -
 71:                                                                           -
 72:                                                                           -
 73:                                                                           -
 74:                                                                           -
 75:                                                                           -
 76:                                                                           -
 77:                                                                           -
 78:                                                                           -
 79:                                           M                               u
 80:                                           M                               u
 81:                                                                           -
 82:                                                                           -
 83:                                                                           -
 84:                                                                           -
 85:                                                                           -
 86:                                                                           -
 87:                                                                           -
 88:                                                                           -
 89:                                                                           -
 90:                                                                           -
 91:                                                                           -
 92:                                                                           -
 93:                                                                           -
 94:                                                                           -
 95:                                                                           -
 96:                                                                           -
 97:                                                                           -
 98:                                                                           -
 99:                                           T                               p
100:                                           M                               u
     flagObservationStatus_measuredElement_5312 flagMethod_measuredElement_5312
     Value_measuredElement_5525 flagObservationStatus_measuredElement_5525
  1:                                         NA                               M
  2:                                         NA                               M
  3:                                         NA                               M
  4:                                         NA                               M
  5:                                         NA                               M
  6:                                         NA                               M
  7:                                         NA                               M
  8:                                         NA                               M
  9:                                         NA                               M
 10:                                         NA                               M
 11:                                         NA                               M
 12:                                         NA                               M
 13:                                         NA                               M
 14:                                         NA                               M
 15:                                     396000
```

16:	753000	
17:	NA	M
18:	NA	M
19:	NA	M
20:	NA	M
21:	NA	M
22:	NA	M
23:	NA	M
24:	NA	M
25:	NA	M
26:	NA	M
27:	NA	M
28:	NA	M
29:	NA	M
30:	NA	M
31:	NA	M
32:	NA	M
33:	NA	M
34:	NA	M
35:	NA	M
36:	NA	M
37:	NA	M
38:	NA	M
39:	NA	M
40:	NA	M
41:	1450000	T
42:	1450000	T
43:	1450000	T
44:	1450000	T
45:	1450000	T
46:	1450000	T
47:	1450000	T
48:	1450000	T
49:	1450000	T
50:	700000	T
51:	1450000	T
52:	1540000	T
53:	1300000	T
54:	1500000	T
55:	1800000	T
56:	1750000	T
57:	1840000	T
58:	1800000	E
59:	NA	M
60:	NA	M
61:	7600	
62:	4500	
63:	5000	
64:	4500	
65:	5046	
66:	5066	

```
 67:                    4763
 68:                    4400
 69:                    4697
 70:                    5507
 71:                    4143
 72:                    3665
 73:                    4460
 74:                    2097
 75:                    2300
 76:                    2325
 77:                    2689
 78:                      NA                                                    M
 79:                      NA                                                    M
 80:                      NA                                                    M
 81:                  266220
 82:                  275650
 83:                  242885
 84:                  322661
 85:                  229715
 86:                  214647
 87:                  224580
 88:                  239291
 89:                  142524
 90:                   56871
 91:                   62857
 92:                  282680
 93:                  281626
 94:                  281626
 95:                  289033
 96:                  278308
 97:                  258829
 98:                  260000                                                    E
 99:                      NA                                                    M
100:                      NA                                                    M
     Value_measuredElement_5525 flagObservationStatus_measuredElement_5525
     flagMethod_measuredElement_5525 Value_areaSownRatio
  1:                                    u                  1
  2:                                    u                  1
  3:                                    u                  1
  4:                                    u                  1
  5:                                    u                  1
  6:                                    u                  1
  7:                                    u                  1
  8:                                    u                  1
  9:                                    u                  1
 10:                                    u                  1
 11:                                    u                  1
 12:                                    u                  1
 13:                                    u                  1
 14:                                    u                  1
 15:                                    -                  1
```

16:	–	1
17:	u	1
18:	u	1
19:	u	1
20:	u	1
21:	u	1
22:	u	1
23:	u	1
24:	u	1
25:	u	1
26:	u	1
27:	u	1
28:	u	1
29:	u	1
30:	u	1
31:	u	1
32:	u	1
33:	u	1
34:	u	1
35:	u	1
36:	u	1
37:	u	1
38:	u	1
39:	u	1
40:	u	1
41:	p	1
42:	p	1
43:	p	1
44:	p	1
45:	p	1
46:	p	1
47:	p	1
48:	p	1
49:	p	1
50:	p	1
51:	p	1
52:	p	1
53:	p	1
54:	p	1
55:	p	1
56:	p	1
57:	p	1
58:	f	1
59:	u	1
60:	u	1
61:	–	1
62:	–	1
63:	–	1
64:	–	1
65:	–	1
66:	–	1

```
 67:                              -              1
 68:                              -              1
 69:                              -              1
 70:                              -              1
 71:                              -              1
 72:                              -              1
 73:                              -              1
 74:                              -              1
 75:                              -              1
 76:                              -              1
 77:                              -              1
 78:                              u              1
 79:                              u              1
 80:                              u              1
 81:                              -              1
 82:                              -              1
 83:                              -              1
 84:                              -              1
 85:                              -              1
 86:                              -              1
 87:                              -              1
 88:                              -              1
 89:                              -              1
 90:                              -              1
 91:                              -              1
 92:                              -              1
 93:                              -              1
 94:                              -              1
 95:                              -              1
 96:                              -              1
 97:                              -              1
 98:                              f              1
 99:                              u              1
100:                              u              1
     flagMethod_measuredElement_5525 Value_areaSownRatio
     flagObservationStatus_areaSownRatio flagMethod_areaSownRatio
  1:                                         I                        e
  2:                                         I                        e
  3:                                         I                        e
  4:                                         I                        e
  5:                                         I                        e
  6:                                         I                        e
  7:                                         I                        e
  8:                                         I                        e
  9:                                         I                        e
 10:                                         I                        e
 11:                                         I                        e
 12:                                         I                        e
 13:                                         I                        e
 14:                                         I                        e
 15:                                         I                        e
```

```
16:                          I                    e
17:                          I                    e
18:                          I                    e
19:                          I                    e
20:                          I                    e
21:                          I                    e
22:                          I                    e
23:                          I                    e
24:                          I                    e
25:                          I                    e
26:                          I                    e
27:                          I                    e
28:                          I                    e
29:                          I                    e
30:                          I                    e
31:                          I                    e
32:                          I                    e
33:                          I                    e
34:                          I                    e
35:                          I                    e
36:                          I                    e
37:                          I                    e
38:                          I                    e
39:                          I                    e
40:                          I                    e
41:                          I                    e
42:                          I                    e
43:                          I                    e
44:                          I                    e
45:                          I                    e
46:                          I                    e
47:                          I                    e
48:                          I                    e
49:                          I                    e
50:                          I                    e
51:                          I                    e
52:                          I                    e
53:                          I                    e
54:                          I                    e
55:                          I                    e
56:                          I                    e
57:                          I                    e
58:                          I                    e
59:                          I                    e
60:                          I                    e
61:                          I                    e
62:                          I                    e
63:                          I                    e
64:                          I                    e
65:                          I                    e
66:                          I                    e
```

```
 67:                                        I                        e
 68:                                        I                        e
 69:                                        I                        e
 70:                                        I                        e
 71:                                        I                        e
 72:                                        I                        e
 73:                                        I                        e
 74:                                        I                        e
 75:                                        I                        e
 76:                                        I                        e
 77:                                        I                        e
 78:                                        I                        e
 79:                                        I                        e
 80:                                        I                        e
 81:                                        I                        e
 82:                                        I                        e
 83:                                        I                        e
 84:                                        I                        e
 85:                                        I                        e
 86:                                        I                        e
 87:                                        I                        e
 88:                                        I                        e
 89:                                        I                        e
 90:                                        I                        e
 91:                                        I                        e
 92:                                        I                        e
 93:                                        I                        e
 94:                                        I                        e
 95:                                        I                        e
 96:                                        I                        e
 97:                                        I                        e
 98:                                        I                        e
 99:                                        I                        e
100:                                        I                        e
     flagObservationStatus_areaSownRatio flagMethod_areaSownRatio

> data[geographicAreaM49 == 100,
+      .(time = timePointYears, areaSown = Value_measuredElement_5212,
+        areaHarvested = Value_measuredElement_5312, Value_areaSownRatio)]

    time areaSown areaHarvested Value_areaSownRatio
 1: 1994  1319760       1319760                   1
 2: 1995  1181120       1181120                   1
 3: 1996   957670        957670                   1
 4: 1997  1211720       1211720                   1
 5: 1998  1141682       1141682                   1
 6: 1999   966282        966282                   1
 7: 2000   978575        978575                   1
 8: 2001  1355500       1355500                   1
 9: 2002  1368627       1368627                   1
10: 2003   841014        841014                   1
11: 2004  1039680       1039680                   1
```

```
12: 2005   1101807        1101807                    1
13: 2006    970392         970392                    1
14: 2007   1087996        1087996                    1
15: 2008   1111533        1111533                    1
16: 2009   1247718        1247718                    1
17: 2010   1137650        1137650                    1
18: 2011   1137642        1137642                    1
19: 2012   1090000        1090000                    1
20: 2013       NA             NA                     1

> imputeAreaSown(data = data, codeAreaSown = "5212")


    geographicAreaM49 measuredItemCPC timePointYears
 1:              100            0111           1994
 2:              100            0111           1995
 3:              100            0111           1996
 4:              100            0111           1997
 5:              100            0111           1998
 6:              100            0111           1999
 7:              100            0111           2000
 8:              100            0111           2001
 9:              100            0111           2002
10:              100            0111           2003
11:              100            0111           2004
12:              100            0111           2005
13:              100            0111           2006
14:              100            0111           2007
15:              100            0111           2008
16:              100            0111           2009
17:              100            0111           2010
18:              100            0111           2011
19:              100            0111           2012
20:              100            0111           2013
21:              894            0111           1994
22:              894            0111           1995
23:              894            0111           1996
24:              894            0111           1997
25:              894            0111           1998
26:              894            0111           1999
27:              894            0111           2000
28:              894            0111           2001
29:              894            0111           2002
30:              894            0111           2003
31:              894            0111           2004
32:              894            0111           2005
33:              894            0111           2006
34:              894            0111           2007
35:              894            0111           2008
36:              894            0111           2009
37:              894            0111           2010
38:              894            0111           2011
39:              894            0111           2012
```

40:	894	0111	2013
41:	804	0111	1994
42:	804	0111	1995
43:	804	0111	1996
44:	804	0111	1997
45:	804	0111	1998
46:	804	0111	1999
47:	804	0111	2000
48:	804	0111	2001
49:	804	0111	2002
50:	804	0111	2003
51:	804	0111	2004
52:	804	0111	2005
53:	804	0111	2006
54:	804	0111	2007
55:	804	0111	2008
56:	804	0111	2009
57:	804	0111	2010
58:	804	0111	2011
59:	804	0111	2012
60:	804	0111	2013
61:	400	0111	1994
62:	400	0111	1995
63:	400	0111	1996
64:	400	0111	1997
65:	400	0111	1998
66:	400	0111	1999
67:	400	0111	2000
68:	400	0111	2001
69:	400	0111	2002
70:	400	0111	2003
71:	400	0111	2004
72:	400	0111	2005
73:	400	0111	2006
74:	400	0111	2007
75:	400	0111	2008
76:	400	0111	2009
77:	400	0111	2010
78:	400	0111	2011
79:	400	0111	2012
80:	400	0111	2013
81:	348	0111	1994
82:	348	0111	1995
83:	348	0111	1996
84:	348	0111	1997
85:	348	0111	1998
86:	348	0111	1999
87:	348	0111	2000
88:	348	0111	2001
89:	348	0111	2002
90:	348	0111	2003

```
 91:                 348        0111             2004
 92:                 348        0111             2005
 93:                 348        0111             2006
 94:                 348        0111             2007
 95:                 348        0111             2008
 96:                 348        0111             2009
 97:                 348        0111             2010
 98:                 348        0111             2011
 99:                 348        0111             2012
100:                 348        0111             2013
     geographicAreaM49 measuredItemCPC timePointYears
     Value_measuredElement_5212 flagObservationStatus_measuredElement_5212
  1:                 1319760                                              I
  2:                 1181120                                              I
  3:                  957670                                              I
  4:                 1211720                                              I
  5:                 1141682                                              I
  6:                  966282                                              I
  7:                  978575                                              I
  8:                 1355500                                              I
  9:                 1368627                                              I
 10:                  841014                                              I
 11:                 1039680                                              I
 12:                 1101807                                              I
 13:                  970392                                              I
 14:                 1087996                                              I
 15:                 1111533                                              I
 16:                 1247718                                              I
 17:                 1137650                                              I
 18:                 1137642                                              I
 19:                 1090000                                              I
 20:                      NA                                              M
 21:                   11566                                              I
 22:                    7806                                              I
 23:                   10327                                              I
 24:                   10693                                              I
 25:                   11278                                              I
 26:                    9921                                              I
 27:                   12077                                              I
 28:                   12000                                              I
 29:                   12000                                              I
 30:                   21000                                              I
 31:                   13543                                              I
 32:                   22033                                              I
 33:                   17100                                              I
 34:                   18833                                              I
 35:                   11394                                              I
 36:                   34296                                              I
 37:                   27291                                              I
 38:                   37631                                              I
 39:                      NA                                              M
```

```
40:                    NA                                M
41:               4507000                                I
42:               5479400                                I
43:               5891800                                I
44:               6508400                                I
45:               5641000                                I
46:               5931600                                I
47:               5161600                                I
48:               6882000                                I
49:               6749600                                I
50:               2456400                                I
51:               5533700                                I
52:               6571000                                I
53:               5511000                                I
54:               5951300                                I
55:               7053600                                I
56:               6752900                                I
57:               6284100                                I
58:               6657300                                I
59:               6400000                                I
60:                    NA                                M
61:                 29715                                I
62:                 40555                                I
63:                 28349                                I
64:                 37920                                I
65:                 28835                                I
66:                  4087                                I
67:                 18204                                I
68:                 13449                                I
69:                 32745                                I
70:                 29781                                I
71:                 10728                                I
72:                 29292                                I
73:                 26920                                I
74:                 20760                                I
75:                 12456                                I
76:                 15878                                I
77:                 21466                                I
78:                 14330                                I
79:                    NA                                M
80:                    NA                                M
81:               1058749                                I
82:               1108000                                I
83:               1193340                                I
84:               1247569                                I
85:               1183540                                I
86:                734100                                I
87:               1024430                                I
88:               1205610                                I
89:               1110471                                I
90:               1113755                                I
```

```
 91:                      1173800                                                      I
 92:                      1130719                                                      I
 93:                      1074735                                                      I
 94:                      1111269                                                      I
 95:                      1125629                                                      I
 96:                      1146456                                                      I
 97:                      1011182                                                      I
 98:                       978000                                                      I
 99:                      1080000                                                      I
100:                           NA                                                      M
     Value_measuredElement_5212 flagObservationStatus_measuredElement_5212
     flagMethod_measuredElement_5212 Value_measuredElement_5312
  1:                                                    e                       1319760
  2:                                                    e                       1181120
  3:                                                    e                        957670
  4:                                                    e                       1211720
  5:                                                    e                       1141682
  6:                                                    e                        966282
  7:                                                    e                        978575
  8:                                                    e                       1355500
  9:                                                    e                       1368627
 10:                                                    e                        841014
 11:                                                    e                       1039680
 12:                                                    e                       1101807
 13:                                                    e                        970392
 14:                                                    e                       1087996
 15:                                                    e                       1111533
 16:                                                    e                       1247718
 17:                                                    e                       1137650
 18:                                                    e                       1137642
 19:                                                    e                       1090000
 20:                                                    e                            NA
 21:                                                    e                         11566
 22:                                                    e                          7806
 23:                                                    e                         10327
 24:                                                    e                         10693
 25:                                                    e                         11278
 26:                                                    e                          9921
 27:                                                    e                         12077
 28:                                                    e                         12000
 29:                                                    e                         12000
 30:                                                    e                         21000
 31:                                                    e                         13543
 32:                                                    e                         22033
 33:                                                    e                         17100
 34:                                                    e                         18833
 35:                                                    e                         11394
 36:                                                    e                         34296
 37:                                                    e                         27291
 38:                                                    e                         37631
 39:                                                    e                            NA
```

```
40:                          e                          NA
41:                          e                     4507000
42:                          e                     5479400
43:                          e                     5891800
44:                          e                     6508400
45:                          e                     5641000
46:                          e                     5931600
47:                          e                     5161600
48:                          e                     6882000
49:                          e                     6749600
50:                          e                     2456400
51:                          e                     5533700
52:                          e                     6571000
53:                          e                     5511000
54:                          e                     5951300
55:                          e                     7053600
56:                          e                     6752900
57:                          e                     6284100
58:                          e                     6657300
59:                          e                     6400000
60:                          e                          NA
61:                          e                       29715
62:                          e                       40555
63:                          e                       28349
64:                          e                       37920
65:                          e                       28835
66:                          e                        4087
67:                          e                       18204
68:                          e                       13449
69:                          e                       32745
70:                          e                       29781
71:                          e                       10728
72:                          e                       29292
73:                          e                       26920
74:                          e                       20760
75:                          e                       12456
76:                          e                       15878
77:                          e                       21466
78:                          e                       14330
79:                          e                          NA
80:                          e                          NA
81:                          e                     1058749
82:                          e                     1108000
83:                          e                     1193340
84:                          e                     1247569
85:                          e                     1183540
86:                          e                      734100
87:                          e                     1024430
88:                          e                     1205610
89:                          e                     1110471
90:                          e                     1113755
```

```
 91:                                    e              1173800
 92:                                    e              1130719
 93:                                    e              1074735
 94:                                    e              1111269
 95:                                    e              1125629
 96:                                    e              1146456
 97:                                    e              1011182
 98:                                    e               978000
 99:                                    e              1080000
100:                                    e                   NA
     flagMethod_measuredElement_5212 Value_measuredElement_5312
     flagObservationStatus_measuredElement_5312 flagMethod_measuredElement_5312
  1:                                                                          -
  2:                                                                          -
  3:                                                                          -
  4:                                                                          -
  5:                                                                          -
  6:                                                                          -
  7:                                                                          -
  8:                                                                          -
  9:                                                                          -
 10:                                                                          -
 11:                                                                          -
 12:                                                                          -
 13:                                                                          -
 14:                                                                          -
 15:                                                                          -
 16:                                                                          -
 17:                                                                          -
 18:                                                                          -
 19:                                    T                                     p
 20:                                    M                                     u
 21:                                                                          -
 22:                                                                          -
 23:                                                                          -
 24:                                                                          -
 25:                                                                          -
 26:                                                                          -
 27:                                                                          -
 28:                                    T                                     p
 29:                                    T                                     p
 30:                                    E                                     f
 31:                                    T                                     p
 32:                                                                          -
 33:                                    T                                     p
 34:                                                                          -
 35:                                                                          -
 36:                                                                          -
 37:                                                                          -
 38:                                                                          -
 39:                                    M                                     u
```

```
40:                                 M                                 u
41:                                                                   -
42:                                                                   -
43:                                                                   -
44:                                                                   -
45:                                                                   -
46:                                                                   -
47:                                                                   -
48:                                                                   -
49:                                                                   -
50:                                                                   -
51:                                                                   -
52:                                                                   -
53:                                                                   -
54:                                                                   -
55:                                                                   -
56:                                                                   -
57:                                                                   -
58:                                                                   -
59:                                 T                                 p
60:                                 M                                 u
61:                                                                   -
62:                                                                   -
63:                                                                   -
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65:                                                                   -
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67:                                                                   -
68:                                                                   -
69:                                                                   -
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71:                                                                   -
72:                                                                   -
73:                                                                   -
74:                                                                   -
75:                                                                   -
76:                                                                   -
77:                                                                   -
78:                                                                   -
79:                                 M                                 u
80:                                 M                                 u
81:                                                                   -
82:                                                                   -
83:                                                                   -
84:                                                                   -
85:                                                                   -
86:                                                                   -
87:                                                                   -
88:                                                                   -
89:                                                                   -
90:                                                                   -
```

```
 91:                                                                    -
 92:                                                                    -
 93:                                                                    -
 94:                                                                    -
 95:                                                                    -
 96:                                                                    -
 97:                                                                    -
 98:                                                                    -
 99:                                              T                     p
100:                                              M                     u
```

flagObservationStatus_measuredElement_5312 flagMethod_measuredElement_5312
Value_measuredElement_5525 flagObservationStatus_measuredElement_5525

```
  1:                          NA                               M
  2:                          NA                               M
  3:                          NA                               M
  4:                          NA                               M
  5:                          NA                               M
  6:                          NA                               M
  7:                          NA                               M
  8:                          NA                               M
  9:                          NA                               M
 10:                          NA                               M
 11:                          NA                               M
 12:                          NA                               M
 13:                          NA                               M
 14:                          NA                               M
 15:                      396000
 16:                      753000
 17:                          NA                               M
 18:                          NA                               M
 19:                          NA                               M
 20:                          NA                               M
 21:                          NA                               M
 22:                          NA                               M
 23:                          NA                               M
 24:                          NA                               M
 25:                          NA                               M
 26:                          NA                               M
 27:                          NA                               M
 28:                          NA                               M
 29:                          NA                               M
 30:                          NA                               M
 31:                          NA                               M
 32:                          NA                               M
 33:                          NA                               M
 34:                          NA                               M
 35:                          NA                               M
 36:                          NA                               M
 37:                          NA                               M
 38:                          NA                               M
 39:                          NA                               M
```

```
40:                    NA                                    M
41:               1450000                                    T
42:               1450000                                    T
43:               1450000                                    T
44:               1450000                                    T
45:               1450000                                    T
46:               1450000                                    T
47:               1450000                                    T
48:               1450000                                    T
49:               1450000                                    T
50:                700000                                    T
51:               1450000                                    T
52:               1540000                                    T
53:               1300000                                    T
54:               1500000                                    T
55:               1800000                                    T
56:               1750000                                    T
57:               1840000                                    T
58:               1800000                                    E
59:                    NA                                    M
60:                    NA                                    M
61:                  7600
62:                  4500
63:                  5000
64:                  4500
65:                  5046
66:                  5066
67:                  4763
68:                  4400
69:                  4697
70:                  5507
71:                  4143
72:                  3665
73:                  4460
74:                  2097
75:                  2300
76:                  2325
77:                  2689
78:                    NA                                    M
79:                    NA                                    M
80:                    NA                                    M
81:                266220
82:                275650
83:                242885
84:                322661
85:                229715
86:                214647
87:                224580
88:                239291
89:                142524
90:                 56871
```

```
 91:                      62857
 92:                     282680
 93:                     281626
 94:                     281626
 95:                     289033
 96:                     278308
 97:                     258829
 98:                     260000                                              E
 99:                         NA                                              M
100:                         NA                                              M
    Value_measuredElement_5525 flagObservationStatus_measuredElement_5525
    flagMethod_measuredElement_5525 Value_areaSownRatio
  1:                                               u                 1
  2:                                               u                 1
  3:                                               u                 1
  4:                                               u                 1
  5:                                               u                 1
  6:                                               u                 1
  7:                                               u                 1
  8:                                               u                 1
  9:                                               u                 1
 10:                                               u                 1
 11:                                               u                 1
 12:                                               u                 1
 13:                                               u                 1
 14:                                               u                 1
 15:                                               -                 1
 16:                                               -                 1
 17:                                               u                 1
 18:                                               u                 1
 19:                                               u                 1
 20:                                               u                 1
 21:                                               u                 1
 22:                                               u                 1
 23:                                               u                 1
 24:                                               u                 1
 25:                                               u                 1
 26:                                               u                 1
 27:                                               u                 1
 28:                                               u                 1
 29:                                               u                 1
 30:                                               u                 1
 31:                                               u                 1
 32:                                               u                 1
 33:                                               u                 1
 34:                                               u                 1
 35:                                               u                 1
 36:                                               u                 1
 37:                                               u                 1
 38:                                               u                 1
 39:                                               u                 1
```

```
40:                          u                    1
41:                          p                    1
42:                          p                    1
43:                          p                    1
44:                          p                    1
45:                          p                    1
46:                          p                    1
47:                          p                    1
48:                          p                    1
49:                          p                    1
50:                          p                    1
51:                          p                    1
52:                          p                    1
53:                          p                    1
54:                          p                    1
55:                          p                    1
56:                          p                    1
57:                          p                    1
58:                          f                    1
59:                          u                    1
60:                          u                    1
61:                          –                    1
62:                          –                    1
63:                          –                    1
64:                          –                    1
65:                          –                    1
66:                          –                    1
67:                          –                    1
68:                          –                    1
69:                          –                    1
70:                          –                    1
71:                          –                    1
72:                          –                    1
73:                          –                    1
74:                          –                    1
75:                          –                    1
76:                          –                    1
77:                          –                    1
78:                          u                    1
79:                          u                    1
80:                          u                    1
81:                          –                    1
82:                          –                    1
83:                          –                    1
84:                          –                    1
85:                          –                    1
86:                          –                    1
87:                          –                    1
88:                          –                    1
89:                          –                    1
90:                          –                    1
```

```
  91:                                    -                     1
  92:                                    -                     1
  93:                                    -                     1
  94:                                    -                     1
  95:                                    -                     1
  96:                                    -                     1
  97:                                    -                     1
  98:                                    f                     1
  99:                                    u                     1
 100:                                    u                     1
      flagMethod_measuredElement_5525 Value_areaSownRatio
      flagObservationStatus_areaSownRatio flagMethod_areaSownRatio
   1:                                    I                     e
   2:                                    I                     e
   3:                                    I                     e
   4:                                    I                     e
   5:                                    I                     e
   6:                                    I                     e
   7:                                    I                     e
   8:                                    I                     e
   9:                                    I                     e
  10:                                    I                     e
  11:                                    I                     e
  12:                                    I                     e
  13:                                    I                     e
  14:                                    I                     e
  15:                                    I                     e
  16:                                    I                     e
  17:                                    I                     e
  18:                                    I                     e
  19:                                    I                     e
  20:                                    I                     e
  21:                                    I                     e
  22:                                    I                     e
  23:                                    I                     e
  24:                                    I                     e
  25:                                    I                     e
  26:                                    I                     e
  27:                                    I                     e
  28:                                    I                     e
  29:                                    I                     e
  30:                                    I                     e
  31:                                    I                     e
  32:                                    I                     e
  33:                                    I                     e
  34:                                    I                     e
  35:                                    I                     e
  36:                                    I                     e
  37:                                    I                     e
  38:                                    I                     e
  39:                                    I                     e
```

```
40:                        I                    e
41:                        I                    e
42:                        I                    e
43:                        I                    e
44:                        I                    e
45:                        I                    e
46:                        I                    e
47:                        I                    e
48:                        I                    e
49:                        I                    e
50:                        I                    e
51:                        I                    e
52:                        I                    e
53:                        I                    e
54:                        I                    e
55:                        I                    e
56:                        I                    e
57:                        I                    e
58:                        I                    e
59:                        I                    e
60:                        I                    e
61:                        I                    e
62:                        I                    e
63:                        I                    e
64:                        I                    e
65:                        I                    e
66:                        I                    e
67:                        I                    e
68:                        I                    e
69:                        I                    e
70:                        I                    e
71:                        I                    e
72:                        I                    e
73:                        I                    e
74:                        I                    e
75:                        I                    e
76:                        I                    e
77:                        I                    e
78:                        I                    e
79:                        I                    e
80:                        I                    e
81:                        I                    e
82:                        I                    e
83:                        I                    e
84:                        I                    e
85:                        I                    e
86:                        I                    e
87:                        I                    e
88:                        I                    e
89:                        I                    e
90:                        I                    e
```

```
 91:                                    I                        e
 92:                                    I                        e
 93:                                    I                        e
 94:                                    I                        e
 95:                                    I                        e
 96:                                    I                        e
 97:                                    I                        e
 98:                                    I                        e
 99:                                    I                        e
100:                                    I                        e
     flagObservationStatus_areaSownRatio flagMethod_areaSownRatio


> data[geographicAreaM49 == 100,
+      .(time = timePointYears, areaSown = Value_measuredElement_5212,
+        areaHarvested = Value_measuredElement_5312, Value_areaSownRatio)]


    time areaSown areaHarvested Value_areaSownRatio
 1: 1994  1319760       1319760                   1
 2: 1995  1181120       1181120                   1
 3: 1996   957670        957670                   1
 4: 1997  1211720       1211720                   1
 5: 1998  1141682       1141682                   1
 6: 1999   966282        966282                   1
 7: 2000   978575        978575                   1
 8: 2001  1355500       1355500                   1
 9: 2002  1368627       1368627                   1
10: 2003   841014        841014                   1
11: 2004  1039680       1039680                   1
12: 2005  1101807       1101807                   1
13: 2006   970392        970392                   1
14: 2007  1087996       1087996                   1
15: 2008  1111533       1111533                   1
16: 2009  1247718       1247718                   1
17: 2010  1137650       1137650                   1
18: 2011  1137642       1137642                   1
19: 2012  1090000       1090000                   1
20: 2013       NA            NA                   1
```

The two cases above are identical. Using an ensemble provides no advantage as no area sown data is originally available.

2.3. Estimate Seed Rate

For this vignette, we will proceed with the dataset defined above: seedData with a CPC code of 0111.

The next step in getting the seed usage is to estimate the seeding rate. The database stores two tables, default_seed_rate and specific_seed_rate, which contain estimates for seed rates. The specific seed rate table contains values for country commodity pairs, while the default seed rate contains average values for commodities overall. It would therefore be preferable to use the specific_seed_rate table, but values are not always available for all countries. Thus, the default_seed_rate table is used when entries are not available in the specific_seed_rate table.

```
> # countrySpecificData = getCountrySpecificSeedRate()
> countrySpecificData = data.table(
+      geographicAreaM49 = c("100", "348", "400"),
+      measuredItemCPC = "0111",
+      Value_seedRate = c(222, 213, 115),
+      flagObservationStatus_seedRate = c("E", "E", ""))
> setkeyv(countrySpecificData, c("geographicAreaM49", "measuredItemCPC"))
> fillCountrySpecificSeedRate(data = data,
+                             countrySpecificData = countrySpecificData)
> head(data, 1)


   geographicAreaM49 measuredItemCPC timePointYears Value_measuredElement_5212
1:               100           0111           1994                    1319760
   flagObservationStatus_measuredElement_5212 flagMethod_measuredElement_5212
1:                                          I                               e
   Value_measuredElement_5312 flagObservationStatus_measuredElement_5312
1:                    1319760
   flagMethod_measuredElement_5312 Value_measuredElement_5525
1:                               -                         NA
   flagObservationStatus_measuredElement_5525 flagMethod_measuredElement_5525
1:                                          M                               u
   Value_areaSownRatio flagObservationStatus_areaSownRatio
1:                   1                                   I
   flagMethod_areaSownRatio Value_seedRate flagObservationStatus_seedRate
1:                        e            222                              E


> data[, Value_seedRate]


  [1] 222 222 222 222 222 222 222 222 222 222 222 222 222 222 222 222 222 222
 [19] 222 222 213 213 213 213 213 213 213 213 213 213 213 213 213 213 213 213
 [37] 213 213 213 213 115 115 115 115 115 115 115 115 115 115 115 115 115 115
 [55] 115 115 115 115 115 115  NA  NA  NA  NA  NA  NA  NA  NA  NA  NA  NA  NA
 [73]  NA  NA  NA  NA  NA  NA  NA  NA  NA  NA  NA  NA  NA  NA  NA  NA  NA  NA
 [91]  NA  NA  NA  NA  NA  NA  NA  NA  NA  NA
```

The getCountrySpecificSeedRate function simply pulls the specific_seed_rate table from the database. This table is also the default value for countrySpecificData in the fillCountrySpecific-SeedRate function, so generally it will not need to be created as here (although it could be created manually from the commented out line above). However, for vignette creation, it was simpler to just create the part of the table we used at the time of the writing, and this is what is done here. The fillCountrySpecificSeedRate function adds an additional two columns to data with the seedRate value and observation flags.

```
> # generalSeedData = getCountryGeneralSeedRate()
> generalSeedData = data.table(measuredItemCPC = "0111", Value_seedRate = 151.14,
+                              flagObservationStatus_seedRate = "")
> setkeyv(generalSeedData, "measuredItemCPC")
> fillGeneralSeedRate(data = data,
+                     generalSeedData = generalSeedData)
> head(data, 1)
```

```
   geographicAreaM49 measuredItemCPC timePointYears Value_measuredElement_5212
1:               100          0111          1994                     1319760
   flagObservationStatus_measuredElement_5212 flagMethod_measuredElement_5212
1:                                          I                                e
   Value_measuredElement_5312 flagObservationStatus_measuredElement_5312
1:                    1319760
   flagMethod_measuredElement_5312 Value_measuredElement_5525
1:                              -                          NA
   flagObservationStatus_measuredElement_5525 flagMethod_measuredElement_5525
1:                                          M                                u
   Value_areaSownRatio flagObservationStatus_areaSownRatio
1:                   1                                  I
   flagMethod_areaSownRatio Value_seedRate flagObservationStatus_seedRate
1:                      e            222                              E
```

```
> data[, Value_seedRate]

  [1] 222.00 222.00 222.00 222.00 222.00 222.00 222.00 222.00 222.00 222.00
 [11] 222.00 222.00 222.00 222.00 222.00 222.00 222.00 222.00 222.00 222.00
 [21] 213.00 213.00 213.00 213.00 213.00 213.00 213.00 213.00 213.00 213.00
 [31] 213.00 213.00 213.00 213.00 213.00 213.00 213.00 213.00 213.00 213.00
 [41] 115.00 115.00 115.00 115.00 115.00 115.00 115.00 115.00 115.00 115.00
 [51] 115.00 115.00 115.00 115.00 115.00 115.00 115.00 115.00 115.00 115.00
 [61] 151.14 151.14 151.14 151.14 151.14 151.14 151.14 151.14 151.14 151.14
 [71] 151.14 151.14 151.14 151.14 151.14 151.14 151.14 151.14 151.14 151.14
 [81] 151.14 151.14 151.14 151.14 151.14 151.14 151.14 151.14 151.14 151.14
 [91] 151.14 151.14 151.14 151.14 151.14 151.14 151.14 151.14 151.14 151.14
```

This function updates all the NA values to the ("global") default seeding rate for this commodity.

2.4. Estimate Seed Usage

The seed usage is estimated by way of the imputeSeed function:

Not all seeds have been imputed. To understand why, note that area sown is available for all years except the last year. But, area sown on year t corresponds to seed usage on year $t - 1$, thus we don't have enough valid observations to impute either of the last two seed usages. These values remain missing, as seen above.

2.5. Push data back to database

Lastly, we must push the imputed data back to the database. This is done via the saveSeedData function (not evaluated, as the token would need to be valid).

```
> saveSeedData(data)
```

Note: this function assumes certain swsContext files exist within your workspace, although it does not require you to pass them to it. So, be careful not to rm those files!

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URL: https://github.com/rockclimber112358/sws_seed