Available online at www.isas.org.in/jisas
Journal of the Indian Society of Agricultural Statistics 77(1) 2023 95–104

Sampling Methodology for Estimation of Private Food grains Stock at Farm Level Aligned with Input Survey of Agriculture Census in India

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Received 06 March 2023; Revised 06 May 2023; Accepted 08 May 2023

SUMMARY

In India, Food and Agriculture Organization of the United Nations (FAO) was implementing a project "Strengthening Agriculture Market Information System (AMIS) in India using Innovative Methods and Digital Technology" and supporting the efforts of the Ministry of Agriculture and Farmers Welfare, Govt. of India. This project identified the potential of improving the data coverage on 'on-farm' post-harvest management of food grains through Input Survey carried out in Agriculture Census. Therefore, a pilot study on private food grains stock estimation at farm level aligned with Input Survey of Agriculture Census in India funded by FAO-India was conducted by ICAR-Indian Agricultural Statistics Research Institute (ICAR-IASRI). Under this study, a suitable sampling methodology aligned with existing Input Survey for estimation of private food grain stock at farm level has been developed. A suitable questionnaire aligned with existing Input Survey of Agriculture Census has been developed covering different food grains stock at farm level.

Under this study, a pilot survey was conducted in two states namely Haryana and Madhya Pradesh. The four crops under AMIS study i.e. wheat, paddy, maize and soybean along with pulses were covered under this pilot survey. The data was collected for all the three seasons. The estimates of food grains stock, pre-harvest opening stock, production obtained, quantity sold, quantity stored, quantity disposed and percentage stock at farm level were obtained along with its percentage Coefficient of Variation (% CV) and were found to be reasonably good for overall size classes. Therefore, it is expected that for overall holding size classes, the proposed methodology will provide farm level reliable estimates of food grains stock at district level. The study has established the feasibility of inclusion of developed questionnaire in the future Input Survey of Agriculture Census in India in order to estimate the food grains stock at farm level which will bridge the gap on private food grains stock in on-farm and off-farm domains of the supply chain.

Keywords: Food grains stock; Input survey; Agriculture Census; Supply chain; Percentage stock, Sampling methodology.

1. INTRODUCTION

Agriculture is one of the important sectors of the Indian economy. About 50% Indian population still relies on agriculture as its principal source of income and serves as a source of raw material for a large number of industries. Indian agriculture had shown tremendous evolution since independence and converted India as exporting country from importer even after fourfold increase in population. Increasing agricultural production is one aspect of fulfilling food demand and the efficient use of food materials produced and saving them as much as possible is another aspect. Delivering food to the consumers by saving produced commodities from loss in fields, transport, storage, retailing, processing etc. without straining our fields, water and environment seems much better option. After production, agricultural produce undergoes series of post-harvest unit operations, handling stages and storage before they reach to the consumers.

Food grains are harvested at specific times during a year but consumed over longer periods. So producers need to maintain stocks for different uses including home consumption. The nature and extent of public and private stocks of food grains play different but inter-related key roles in functioning of the food market. The objectives of public food grain stocks are creation of a buffer stock, a security stock, meeting emergencies due to natural calamities and to intervene in the market alongside the private sector to ensure a socially optimal level of stock over time. On the other hand, private

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stocking of food grains as an activity takes place with households and traders of different types linking producers and consumers with different objectives.

Many studies have reported that storage of food grains plays a vital role in food supply chain. In developing countries, crops are grown in their respective seasons and after harvesting food grains are stored mostly for whole year to be kept as food reserves or seeds for next season. In developing countries like India, studies reveal that more than 50-60% grains are stored in traditional structures at the household or farm level.

Ramesh (1999) reported that high wastage and value loss are due to lack of storage infrastructure at the farm level. The losses during storage are quantitative and qualitative losses. Gabriel (2006) conducted a study on farmers' choices on post-harvest grain management in Ethiopia. Golob (2009) prepared a manual for FAO named as "On-farm post-harvest management of food grains" with special reference to Africa. Kumar and Kalita (2014) reported that storage losses account for maximum fraction of food grain losses and recommended use of Hermatic storages for storage of food grains. Sharon *et al.* (2014) conducted their research on grain storage management in India and concluded that storage is an important link in the entire procurement and distribution system of food grains, produced seasonally but consumed all the year round.

The losses during storage can be of two types i.e. losses due to biotic factors (rodent/ weevil attack, pest or fungi infestation) and abiotic factors (humidity, rain, temperature) (Abedin *et al.*, 2012). According to Alavi *et al.* (2012), milling losses are highest among the losses during post-harvest operations of rice in five Southeast countries: China, Thailand, Indonesia, Philippines and Vietnam. Jha *et al.* (2015) conducted a nationwide survey in 2012-2014 to assess the harvest and post-harvest losses of major crops and commodities in India.

Dissanayake (2016) discussed on "Technical Report of the Estimate of Private Food Grain Stock in Sri Lanka" during International Seminar on "Approaches and Methodologies for Private Food Grain Stock Measurement" held during 9-11 November, 2016 in New Delhi. Jabbar (2016) highlighted data sources and methodological issues in estimation of private stock of food grains in Bangladesh and discussed the mechanism of good quality stock data collection using proper conceptual and methodological approaches.

The reliable information on private food grains stock in India remains extremely scant and methodologies are not available for assessment of food stock. Therefore, a study entitled "Strengthening Agriculture Market Information System (AMIS) in India using Innovative Methods and Digital Technology" funded by the Bill and Melinda Gates Foundation was implemented by FAO during 2015-2017. This project has examined the aspects of information gap on private food grains stocks on on-farm and off farm domains of the supply chain. The approach to bridge this gap recognized the incidence of 'on-farm' food grain stocks at farm level as the post-harvest farm activity. It has also been recognized that the attempt to improve information on 'on-farm' post-harvest management would not only contribute to bridging data gap for food stock measurement but would also augment farming information that have direct relevance to farm income and farm economy.

Accordingly, the food stock measurement study has identified the potential of improving the data coverage on 'on-farm' post-harvest management of food grains through Input Survey carried out in Agriculture Census in India. Therefore, a pilot study funded by FAO-India was conducted by ICAR-IASRI on private food grains stock estimation at farm level aligned with Input Survey of the then ongoing programme of Agriculture Census 2015-16 in India.

2. PROPOSED SAMPLING DESIGN FOR SELECTION OF SAMPLE AND PROPOSED SAMPLE SIZE

Agriculture Census in India is being conducted in three different phases. The estimates of agricultural characteristics of operational holdings are prepared at tehsil/ district/ state/ national levels. The Phase-III of Agriculture Census is referred as Input Survey and is conducted as a follow up survey to the Agriculture Census (reference year as next Agriculture year to that of the Agriculture Census) to collect data on input use pattern of operational holdings in the country. This survey is conducted in 7% of villages selected in each tehsil (35% of villages selected in Phase-II in each tehsil) and estimate for input characteristics is prepared at district/ state/ national level. Institutional holdings

and holdings operated by persons not residing in the village are excluded in the purview of the Input Survey. The reference year of the Input Survey (Phase-III) is 2016-17 (July 2016-June 2017) for the 10th Agriculture Census 2015-16.

A suitable sampling design i.e. stratified two stage sampling design treating tehsils as strata, villages as first stage units and operational holders as second stage units or ultimate stage units being used in Input Survey was adopted. Thus, in each tehsil, the sampling was to be performed at two stages i.e. a sample of villages and sample of operational holders in the sampled villages. The ultimate sampling unit was an operational holder. In selected villages, operational holdings were grouped into the following five size-groups of operational holdings as given in Table1:

Table 1. Classification of operational holders into five size-groups of operational holdings

S. No.	Size-group of holding	Operated area
1	Marginal	Below 1 ha
2	Small	1 ha and above but below 2 ha
3	Semi-medium	2 ha and above but below 4 ha
4	Medium	4 ha and above but below 10 ha
5	Large	10 ha and above

Four operational holders were selected from each of the above mentioned five size groups of operational holdings. The selection was made separately from each of these size groups following Simple Random Sampling Without Replacement (SRSWOR) method. If in a particular size group, the total number of operational holders were less than 4, all the holders of that size group were covered. If there is no holder in a particular size group, 4 additional holders were selected from the adjacent group. The data for this survey was collected through field enquiries from these selected operational holders of sampled villages.

This being a feasibility study, a survey was conducted in only two identified tehsils of each of the two identified districts. A list of villages where Agriculture Census (phase-II) was already conducted, was prepared for each tehsil. In each tehsil, 35% villages (rounded off to nearest integer) were selected independently by SRSWOR out of 20% of the villages selected in phase-II for the purpose of preparation of sampling frame in order to select sample of operational holdings. It may be noted that the sample size was 7% of total number of villages in a tehsil. In each of the selected villages, out of total number of operational holdings, 20 operational holdings, four holdings for each size group (marginal, small, semi-medium, medium and large) were selected by SRSWOR. Hence, a suitable sample was selected as per sampling design.

Four crops namely wheat, paddy, maize and soybean were to be covered under the study. Keeping in view the four crops to be covered, the identified states for the pilot survey were Haryana and Madhya Pradesh (M.P.). Wheat and paddy are grown in Haryana whereas all the four crops viz. wheat, paddy, maize and soybean are grown in M.P. Using the latest available district-wise area under these four crops published by the Directorate of Economics and Statistics (DES), Govt. of India, Karnal and Ratlam districts were identified in Haryana and M.P. respectively. Wheat and paddy are grown in Karnal and all the four crops are grown in Ratlam. There are five tehsils in Karnal and eight tehsils in Ratlam as per Population Census 2011. The two identified tehsils in Karnal are Assandh and Nilokheri whereas Piploda and Tal tehsils were identified in Ratlam district. The total number of villages in Assandh, Nilokheri, Piploda and Tal tehsils are 55, 78, 92 and 88 respectively. Since the basic relevant data i.e. list of selected villages and list of sampled operational holders in Phase-III (Input Survey with a reference period 2016-17) for the 10^{th} Agriculture Census was not available, the list of selected villages of two tehsils each of Ratlam and Karnal districts for Input Survey 2011-12 was acquired from Directorate of Land Records, Gwalior, M.P. and Panchkula, Haryana respectively. As per the obtained records, number of selected villages in these four tehsils were 4, 7, 6 and 6 respectively. Since, 20 operational holdings were selected randomly from each of the selected villages, the sample size for the pilot survey in Karnal and Ratlam districts was 220 (4×20+7×20) and 240 (6×20+6×20) respectively. Hence, the total sample size for the survey was 460.

A suitable questionnaire aligned with existing Input Survey questionnaires of Agriculture Census was designed in order to capture data relating to the identified parameters. The pilot survey was proposed to be conducted using the designed questionnaire as part of the Input Survey of Agriculture Census.

3. PROPOSED ESTIMATION PROCEDURE

3.1 Estimation of private food grains stock at farm level

The sampling design considered is stratified two stage sampling where two identified tehsils in the district are considered as strata, villages within the tehsil are considered as the first stage units and operational holders are considered as the ultimate stage units.

An estimate of food grains stock i.e. total quantity of crop stored/ opening stock/ production/ quantity sold after harvest/ quantity withdrawn from storage from the selected operational holders of k^{th} size group storing crop c in the b^{th} tehsil is given by

$$\hat{\mathrm{X}}_{b(kc)} = \frac{V_b}{v_b}\sum_{v=1}^{v_b}\frac{F_{bv(k)}}{f_{bv(k)}}\sum_{f=1}^{f_{bv(kc)}} x_{bvf(kc)} \tag{1}$$

where

$x_{bvf(kc)}$ is the total quantity stored/opening stock/ production/ quantity sold after harvest/ quantity withdrawn from storage under crop c for k^{th} size group from the f^{th} operational holder of v^{th} village in the b^{th} tehsil,

V_b is the total number of villages in the b^{th} tehsil,

v_b is the number of villages selected in the b^{th} tehsil,

$F_{bv(k)}$ is the total number of operational holders under k^{th} size group in the v^{th} village in the b^{th} tehsil,

$f_{bv(k)}$ is the number of operational holders selected under k^{th} size group in the v^{th} village in the b^{th} tehsil,

$f_{bv(kc)}$ is the number of operational holders selected under k^{th} size group storing crop c in the v^{th} village in the b^{th} tehsil.

An approximate estimate of variance of the above estimator is given by

$$\hat{V}\left(\hat{X}_{b(kc)}\right) = V_b^2\left(\frac{1}{v_b}-\frac{1}{V_b}\right)\frac{1}{v_{bc}-1}\sum_{v=1}^{v_{bc}}\left(\hat{X}_{bv(kc)}-\hat{\bar{X}}_{bv(kc)}\right)^2 \tag{2}$$

where $\hat{X}_{bv(kc)} = \frac{F_{bv(k)}}{f_{bv(k)}}\sum_{f=1}^{f_{bv(kc)}} x_{bvf(kc)}$, $\hat{\bar{X}}_{bv(kc)} = \frac{1}{v_{bc}}\sum_{v=1}^{v_{bc}}\hat{X}_{bv(kc)}$

and v_{bc} is the number of villages selected in the b^{th} tehsil storing crop c.

Now, combining all strata, an estimate of food grains stock at farmer level i.e. total quantity of crop stored/ opening stock/ production/ quantity sold after harvest/ quantity withdrawn from storage of the selected operational holders of k^{th} size group storing crop c is given by

$$\hat{X}_{(kc)} = \sum_{b=1}^{B}\hat{X}_{b(kc)} \tag{3}$$

where B is the total number of tehsils (strata) identified in the district.

Then, the estimator of percentage Coefficient of Variation (%CV) of the proposed estimator of food grains for k^{th} size group under crop c is given by

$$\%\hat{C}V\left(\hat{X}_{(kc)}\right) = \frac{\sqrt{\hat{V}\left(\hat{X}_{(kc)}\right)}}{\hat{X}_{(kc)}}\times 100 \tag{4}$$

where $\hat{V}\left(\hat{X}_{(kc)}\right) = \sum_{b=1}^{B}\hat{V}\left(\hat{X}_{b(kc)}\right)$.

Again, by combining over all the size groups, an estimate of food grains stock at farmer level i.e. total quantity of crop stored/ opening stock/ production/ quantity sold after harvest/ quantity withdrawn from storage of the selected operational holders storing crop c is given by

$$\hat{X}_{(c)} = \sum_{k=1}^{K}\hat{X}_{(kc)} \tag{5}$$

where K is the total number of size groups considered i.e. 5.

The estimator of %CV of the proposed estimate $\hat{X}_{(c)}$ of food grains under crop c is given by

$$\%\hat{C}V\left(\hat{X}_{(c)}\right) = \frac{\sqrt{\hat{V}\left(\hat{X}_{(c)}\right)}}{\hat{X}_{(c)}}\times 100 = \frac{\sqrt{\sum_{k=1}^{K}\hat{V}\left(\hat{X}_{(kc)}\right)}}{\hat{X}_{(c)}}\times 100. \tag{6}$$

3.2 Estimation of percentage food grains stock during storage at farm level

The sampling design considered is stratified two stage sampling where two identified tehsils are considered as strata, villages within the tehsil are considered as the first stage units and operational holders are considered as the ultimate stage units.

An estimate of total production of crop by the selected operational holders from k^{th} size group growing crop c in the b^{th} tehsil during total enquiry period is given by

$$\hat{P}_{b(kc)} = \frac{V_b}{v_b}\sum_{v=1}^{v_b}\frac{F_{bv(k)}}{f_{bv(k)}}\sum_{f=1}^{f_{bv(kc)}} p_{bvf(kc)} \tag{7}$$

where $p_{bvf(kc)}$ is total production of crop c for k^{th} size group from f^{th} operational holder of v^{th} village in the b^{th} tehsil,

V_b is the total number of villages in the b^{th} tehsil,

v_b is the number of villages selected in the b^{th} tehsil,

$F_{bv(k)}$ is the total number of operational holders under k^{th} size group in the v^{th} village in the b^{th} tehsil,

$f_{bv(k)}$ is the number of operational holders selected under k^{th} size group in the v^{th} village in the b^{th} tehsil,

$f_{bv(kc)}$ is the number of operational holders selected under k^{th} size group growing crop c in the v^{th} village in the b^{th} tehsil.

An estimate of farm level percentage food grains stock (% stock) of crop by enquiry in b^{th} tehsil for k^{th} size group under crop c is given by

$$\hat{S}_{b(kc)} = \frac{\hat{X}_{b(kc)}}{\hat{P}_{b(kc)}} \times 100 \tag{8}$$

where $\hat{X}_{b(kc)}$ is the estimate of total quantity of crop stored by operational holders from k^{th} size group storing crop c in the b^{th} tehsil as given in Equation (1).

An approximate estimate of variance of the above estimator is given by

$$\hat{V}\left(\hat{S}_{b(kc)}\right) = \hat{S}^2_{b(kc)}\left[\frac{\hat{V}\left(\hat{X}_{b(kc)}\right)}{\hat{X}^2_{b(kc)}} + \frac{\hat{V}\left(\hat{P}_{b(kc)}\right)}{\hat{P}^2_{b(kc)}} - 2\frac{\hat{Cov}\left(\hat{X}_{b(kc)}, \hat{P}_{b(kc)}\right)}{\hat{X}_{b(kc)}\hat{P}_{b(kc)}}\right] \tag{9}$$

where

$$\hat{V}\left(\hat{X}_{b(kc)}\right) = V_b^2\left(\frac{1}{v_b} - \frac{1}{V_b}\right)\frac{1}{v_{bc}-1}\sum_{v=1}^{v_{bc}}\left(\hat{X}_{bv(kc)} - \hat{\bar{X}}_{bv(kc)}\right)^2,$$

$$\hat{V}\left(\hat{P}_{b(kc)}\right) = V_b^2\left(\frac{1}{v_b} - \frac{1}{V_b}\right)\frac{1}{v_{bc}-1}\sum_{v=1}^{v_{bc}}\left(\hat{P}_{bv(kc)} - \hat{\bar{P}}_{bv(kc)}\right)^2,$$

$$\hat{Cov}\left(\hat{X}_{b(kc)}, \hat{P}_{b(kc)}\right) = V_b^2\left(\frac{1}{v_b} - \frac{1}{V_b}\right)\frac{1}{v_{bc}-1}\sum_{v=1}^{v_{bc}}\left(\hat{X}_{bv(kc)} - \hat{\bar{X}}_{bv(kc)}\right)\left(\hat{P}_{bv(kc)} - \hat{\bar{P}}_{bv(kc)}\right),$$

$$\hat{P}_{bv(kc)} = \frac{F_{bv(k)}}{f_{bv(k)}}\sum_{f=1}^{f_{bv(kc)}} p_{bvf(kc)}\ ,\ \hat{X}_{bv(kc)} = \frac{F_{bv(k)}}{f_{bv(k)}}\sum_{f=1}^{f_{bv(kc)}} x_{bvf(kc)}\ ,$$

$$\hat{\bar{P}}_{bv(kc)} = \frac{1}{v_{bc}}\sum_{v=1}^{v_{bc}}\hat{P}_{bv(kc)} \text{ and } \hat{\bar{X}}_{bv(kc)} = \frac{1}{v_{bc}}\sum_{v=1}^{v_{bc}}\hat{X}_{bv(kc)}\ .$$

Now, combining all strata, an estimate of farm level % stock of crop by enquiry for k^{th} size group under crop c is given by

$$\hat{S}_{(kc)} = \frac{1}{B}\sum_{b=1}^{B}\hat{S}_{b(kc)}\ . \tag{10}$$

Then, the estimator of %CV of the proposed estimator of % stock for k^{th} size group under crop c is given by

$$\%\hat{C}V\left(\hat{S}_{(kc)}\right) = \frac{\sqrt{\hat{V}\left(\hat{S}_{(kc)}\right)}}{\hat{S}_{(kc)}} \times 100 \tag{11}$$

where $\hat{V}\left(\hat{S}_{(kc)}\right) = \frac{1}{B^2}\sum_{b=1}^{B}\hat{V}\left(\hat{S}_{b(kc)}\right)$.

An estimate of farm level % stock of crop by enquiry in b^{th} tehsil for overall size groups under crop c is given by

$$\hat{S}_{b(c)} = \frac{\hat{X}_{b(c)}}{\hat{P}_{b(c)}} \times 100 = \frac{\sum_{k=1}^{K}\hat{X}_{b(kc)}}{\sum_{k=1}^{K}\hat{P}_{b(kc)}} \times 100\ . \tag{12}$$

An approximate estimate of variance of the above estimator is given by

$$\hat{V}\left(\hat{S}_{b(c)}\right) = \hat{S}^2_{b(c)}\left[\frac{\sum_{k=1}^{K}\hat{V}\left(\hat{X}_{b(kc)}\right)}{\hat{X}^2_{b(c)}} + \frac{\sum_{k=1}^{K}\hat{V}\left(\hat{P}_{b(kc)}\right)}{\hat{P}^2_{b(c)}} - 2\frac{\sum_{k=1}^{K}\hat{Cov}\left(\hat{X}_{b(kc)}, \hat{P}_{b(kc)}\right)}{\hat{X}_{b(c)}\hat{P}_{b(c)}}\right]. \tag{13}$$

Now, combining all strata, an estimate of farm level % stock of crop by enquiry for overall size groups under crop c is given by

$$\hat{S}_{(c)} = \frac{1}{B}\sum_{b=1}^{B}\hat{S}_{b(c)}\ . \tag{14}$$

Then, the estimator of percentage CV of the proposed estimator of percentage % stock for overall size groups under crop c is given by

$$\%\hat{C}V\left(\hat{S}_{(c)}\right) = \frac{\sqrt{\hat{V}\left(\hat{S}_{(c)}\right)}}{\hat{S}_{(c)}} \times 100 \tag{15}$$

where $\hat{V}\left(\hat{S}_{(c)}\right) = \frac{1}{B^2}\sum_{b=1}^{B}\hat{V}\left(\hat{S}_{b(c)}\right)$.

4. RESULTS AND DISCUSSION

Primary data collection was carried out using Paper Assisted Personal Interviewing (PAPI) method. The main aim of the study was measurement of private food grains stock at farm level. All possible indicators in the supply chain up to farmer level were identified and included in the questionnaire used for data collection. The data was captured on the identified indicators such as opening stock, production obtained, quantity sold after harvest and before storage, quantity stored (stock), quantity withdrawn from storage for different uses i.e. home consumption, sale, animal feed, labour charges, seed, other uses, losses and closing stock.

These indicators show the complete supply chain of food grains at farmer level. Opening stock i.e. quantity stored before harvest is the initial variable of the supply chain. Disposal of food grains is a flow variable and is very important variable for the supply chain. There are two different components of disposal i.e. (i) sale after harvest and before storage and (ii) disposal out of storage (stock) which includes all the components such as home consumption, sale, animal feed, labour charges, seed, other uses, losses and closing stock. These indicators are the important variables in the supply chain of food grains up to farmer level. One important derived variable of the supply chain is percentage stock. The percentage stock is nothing but the percentage of ratio of stock and production which has also been estimated and shown.

The complete supply chain of food grains up to farmer level can be best explained with the help of flow chart and the flow chart for the same is given in Fig.1.

The data analysis was carried out using Statistical Analysis System (SAS) software available at ICAR-IASRI, New Delhi. The SAS codes were written as per the proposed estimation procedures for suitable data analysis.

4.1 Crop-wise estimates of different parameters of private food grains at farm level

4.1.1 Karnal district of Haryana State

Two tehsils namely Nilokhedi and Assandh of Karnal district of Haryana State were identified for this study. The data collection work was carried out in 11 selected villages of these two tehsils. Paddy in Kharif season and wheat in Rabi season were two major crops in both the tehsils. The estimates of different parameters

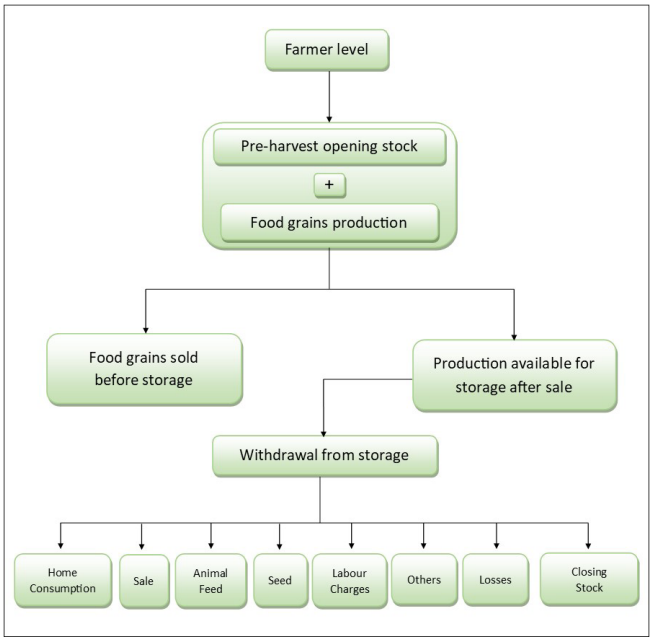

Fig. 1. Supply chain flow chart for selected food grains at farmer level

along with its % CV based on two tehsils are given in the Table 2 and Table 3.

Table 2 shows six different estimates i.e. pre-harvest opening stock, production obtained, quantity sold after harvest and before storage, quantity stored, quantity disposed (withdrawal from storage for different uses) and percentage stock of paddy in the Kharif season of 2016-17 at farm level along with its %CV in two tehsils of Karnal district of Haryana State namely Nilokheri and Assandh. It can be observed that the medium size group is having maximum food stock and quantity disposed has been found to be minimum for large size group. It can be seen that the %CV of the estimates of pre-harvest opening stock, production obtained, quantity sold, quantity stored, quantity disposed and percentage stock for overall size classes are found to be 16.63, 13.77, 13.88, 20.30, 17.64, and 13.48 respectively.

Table 3 shows six different estimates i.e. pre-harvest opening stock, production obtained, quantity sold after harvest and before storage, quantity stored, quantity disposed (withdrawal from storage for different uses) and percentage stock of wheat in the Rabi season of 2015-16 at farm level along with its %CV in two tehsils of Karnal district of Haryana State namely Nilokheri and Assandh. It can be seen that the marginal size group is having maximum food stock and quantity disposed has been found to be minimum for large size group. It may be observed that the %CV of the estimates of pre-

Table 2. Estimates along with % CV of different parameters of Paddy at farm level during Kharif 2016-17 in Karnal district of Haryana

Size Group	Number of villages under Paddy	Number of OH under Paddy	Pre-harvest opening stock (000' MT)		Production (000' MT)		Quantity sold (000' MT)		Quantity stored (stock) (000'MT)		Quantity disposed (withdrawal from storage) (000'MT)		Percentage stock	
			Estimate	% CV	Estimate	% CV	Estimate	% CV	Estimate	% CV	Estimate	% CV	Estimate	% CV
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Marginal (below 1.0 ha)	11	44	1.12	38.82	29.96	31.07	22.19	36.98	8.89	28.46	6.73	28.29	27.90	26.12
Small (1.0 - 1.99 ha)	11	46	1.20	48.17	33.04	33.49	27.74	34.37	6.49	48.85	5.10	46.04	20.28	27.75
Semi-medium (2.0 - 3.99 ha)	11	43	1.25	29.25	74.57	25.71	66.06	24.16	9.76	44.98	6.08	31.8	13.29	25.83
Medium (4.0 - 9.99 ha)	11	52	1.39	25.68	84.99	25.93	74.60	25.86	11.78	43.87	7.83	35.82	14.07	31.82
Large (10.0 ha and above	8	29	0.43	32.64	52.29	36.76	47.57	36.85	5.14	62.96	4.32	62.86	11.91	30.54
Overall size groups		**214**	**5.39**	**16.63**	**274.84**	**13.77**	**238.17**	**13.88**	**42.06**	**20.30**	**30.06**	**17.64**	**15.67**	**13.48**

OH – Operational holders

Table 3. Estimates along with % CV of different parameters of Wheat at farm level during Rabi 2015-16 in Karnal district of Haryana

Size Group	Number of villages under wheat	Number of OH under wheat	Pre-harvest opening stock (000' MT)		Production (000' MT)		Quantity sold (000' MT)		Quantity stored (stock) (000'MT)		Quantity disposed (withdrawal from storage) (000'MT)		Percentage stock	
			Estimate	% CV	Estimate	% CV	Estimate	% CV	Estimate	% CV	Estimate	% CV	Estimate	% CV
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Marginal (below 1.0 ha)	**11**	**45**	**2.65**	**60.28**	**34.54**	**37.02**	**20.15**	**46.57**	**17.04**	**30.53**	**1.42**	**26.99**	**46.38**	**10.44**
Small (1.0 - 1.99 ha)	**11**	**47**	**1.05**	**35.21**	**30.83**	**32.43**	**22.18**	**35.34**	**9.69**	**32.37**	**0.83**	**31.69**	**33.53**	**10.42**
Semi-medium (2.0 - 3.99 ha)	**11**	**45**	**2.93**	**54.19**	**63.21**	**23.8**	**51.02**	**23.04**	**15.12**	**28.29**	**1.09**	**28.02**	**23.12**	**8.61**
Medium (4.0 - 9.99 ha)	**11**	**54**	**2.43**	**37.93**	**82.60**	**25.15**	**68.21**	**25.63**	**16.82**	**33.03**	**1.41**	**35.25**	**20.22**	**23.65**
Large (10.0 ha and above	**8**	**29**	**1.14**	**39.26**	**44.39**	**30.41**	**38.96**	**30.47**	**6.57**	**47.00**	**0.51**	**47.07**	**15.29**	**30.37**
Overall size groups		**220**	**10.21**	**24.52**	**255.58**	**13.00**	**200.51**	**13.52**	**65.26**	**14.98**	**5.26**	**14.89**	**25.06**	**8.67**

OH – Operational holders

harvest opening stock, production obtained, quantity sold, quantity stored, quantity disposed and percentage stock for overall size classes are found to be 24.52, 13.00, 13.52, 14.98, 14.89 and 8.67 respectively.

Therefore, it may be inferred that on the basis of two tehsils in the district, the % CV of the above estimates for overall size classes are quite reasonable indicating the feasibility of getting reliable estimates at district level.

4.1.2 Ratlam district of Madhya Pradesh State

Two tehsils namely Tal and Piploda of Ratlam district of Madhya Pradesh State were identified for this study. The data collection work was carried out in 12 selected villages, six villages in each of the tehsils. Soybean in Kharif season and wheat and gram in Rabi season were the three major crops in both the tehsils. The estimates of different parameters along with its %CV based on two tehsils are given in the Table 4, Table 5 and Table 6.

Table 4. Estimates along with % CV of different parameters of Soybean at farm level during Kharif 2016-17 in Ratlam district of M.P.

Size Group	Number of villages under Soybean	Number of OH under Soybean	Pre-harvest opening stock (000' MT)		Production (000' MT)		Quantity sold (000' MT)		Quantity stored (stock) (000'MT)		Quantity disposed (withdrawal from storage) (000'MT)		Percentage stock	
			Estimate	% CV	Estimate	% CV	Estimate	% CV	Estimate	% CV	Estimate	% CV	Estimate	% CV
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Marginal (below 1.0 ha)	12	53	0.23	38.48	14.51	40.01	13.61	41.45	1.13	28.87	0.66	35.44	12.02	27.67
Small (1.0 - 1.99 ha)	12	44	0.09	81.44	14.85	40.54	12.80	43.78	2.14	33.13	0.82	29.32	16.78	21.63
Semi-medium (2.0 - 3.99 ha)	12	44	0.43	47.60	8.78	19.49	7.70	18.64	1.52	31.88	0.69	30.57	18.28	19.19
Medium (4.0 - 9.99 ha)	11	75	0.32	37.41	10.77	22.98	8.32	20.54	2.74	41.92	1.02	32.39	25.62	27.27
Large (10.0 ha and above)	5	8	0.04	136.52	1.31	75.51	0.99	54.49	0.36	27.53	0.33	26.75	25.51	39.71
Overall size groups		**224**	**1.11**	**24.33**	**50.22**	**17.80**	**43.41**	**19.06**	**7.89**	**18.70**	**3.54**	**14.86**	**17.99**	**16.39**

OH – Operational holders

Table 5. Estimates along with % CV of different parameters of Wheat at farm level during Rabi 2015-16 in Ratlam district of M.P.

Size Group	Number of villages under wheat	Number of OH under wheat	Pre-harvest opening stock (000' MT)		Production (000' MT)		Quantity sold (000' MT)		Quantity stored (stock) (000'MT)		Quantity disposed (withdrawal from storage) (000'MT)		Percentage stock	
			Estimate	% CV	Estimate	% CV	Estimate	% CV	Estimate	% CV	Estimate	% CV	Estimate	% CV
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Marginal (below 1.0 ha)	12	48	0.33	37.51	23.13	48.32	14.29	69.19	9.17	18.16	7.39	20.98	50.38	20.80
Small (1.0 - 1.99 ha)	12	48	0.34	41.59	21.68	40.42	12.67	58.43	9.35	21.18	7.27	20.94	48.30	18.30
Semi-medium (2.0 - 3.99 ha)	12	47	0.64	36.30	19.96	45.90	14.29	50.44	6.31	31.81	4.62	24.28	37.92	18.82
Medium (4.0 - 9.99 ha)	11	76	0.63	46.50	12.86	25.31	9.78	30.54	3.70	16.05	3.00	19.01	28.80	24.04
Large (10.0 ha and above)	5	7	0.03	136.52	1.50	59.64	1.27	65.78	0.25	36.59	0.20	43.30	16.01	38.11
Overall size groups		**226**	**1.96**	**21.34**	**79.13**	**21.78**	**52.30**	**27.98**	**28.79**	**11.57**	**22.49**	**11.18**	**39.56**	**11.57**

OH – Operational holders

Table 4 depicts six different estimates i.e. pre-harvest opening stock, production obtained, quantity sold after harvest and before storage, quantity stored, quantity disposed (withdrawal from storage for different uses) and percentage stock of soybean in the Kharif season of 2016-17 at farm level along with its %CV in two tehsils of Ratlam district of Madhya Pradesh State namely Tal and Piploda. It can be observed that the medium size group is having maximum food stock and quantity disposed has been found to be minimum for large size group. It can be seen that the %CV of the estimates of pre-harvest opening stock, production obtained, quantity sold, quantity stored, quantity disposed and percentage stock for overall size classes are found to be 24.33, 17.80, 19.06, 18.70, 14.86 and 16.39 respectively.

Table 5 reflects six different estimates i.e. pre-harvest opening stock, production obtained, quantity sold after harvest and before storage, quantity stored, quantity disposed (withdrawal from storage for different uses) and percentage stock of wheat in the Rabi season of 2015-16 at farm level along with its %CV in two tehsils of Ratlam district of Madhya Pradesh State namely Tal and Piploda. It can be seen that the marginal size group is having maximum food stock and quantity disposed has been found to be minimum for large size group. It

Table 6. Estimates along with %CV of different parameters of Chickpea (Gram) at farm level during Rabi 2015-16 in Ratlam district of M.P.

Size Group	Number of villages under gram	Number of OH under gram	Pre harvest opening stock (000' MT)		Production (000' MT)		Quantity sold (000' MT)		Quantity stored (stock) (000'MT)		Quantity disposed (withdrawal from storage) (000'MT)		Percentage stock	
			Estimate	% CV	Estimate	% CV	Estimate	% CV	Estimate	% CV	Estimate	% CV	Estimate	% CV
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Marginal (below 1.0 ha)	7	13	-	-	1.35	69.69	1.00	92.94	0.35	27.23	0.34	26.20	38.51	25.81
Small (1.0 - 1.99 ha)	10	28	0.001	82.97	1.38	34.97	0.98	40.61	0.40	25.89	0.33	32.62	27.48	22.61
Semi-medium (2.0 - 3.99 ha)	10	28	0.09	55.98	1.07	19.04	0.82	21.68	0.34	33.56	0.23	38.60	30.48	27.66
Medium (4.0 - 9.99 ha.)	11	53	0.04	56.26	1.64	20.19	1.28	22.25	0.40	16.74	0.28	20.54	25.50	16.36
Large (10.0 ha. and above	4	4	0.01	136.52	0.25	26.19	0.24	25.97	0.02	104.27	0.01	127.86	6.82	149.33
Overall size groups		**126**	**0.14**	**39.64**	**5.70**	**19.85**	**4.33**	**24.69**	**1.51**	**12.88**	**1.20**	**14.78**	**26.53**	**17.53**

OH – Operational holders

may be observed that the %CV of the estimates of pre-harvest opening stock, production obtained, quantity sold, quantity stored, quantity disposed and percentage stock for overall size classes are found to be 21.34, 21.78, 27.98, 11.57, 11.18 and 11.57 respectively.

Table 6 shows six different estimates i.e. pre-harvest opening stock, production obtained, quantity sold after harvest and before storage, quantity stored, quantity disposed (withdrawal from storage for different uses) and percentage stock of chickpea (gram) in the Rabi season of 2015-16 at farm level along with its %CV in two tehsils of Ratlam district of Madhya Pradesh State namely Tal and Piploda. It can be observed that the marginal size group is having maximum food stock and quantity disposed has been found to be minimum for large size group. It may be seen that the %CV of the estimates of pre-harvest opening stock, production obtained, quantity sold, quantity stored, quantity disposed and percentage stock for overall size classes are found to be 39.64, 19.85, 24.69, 12.88, 14.78 and 17.53 respectively. The results for maize crop are not included due to small sample size in this case.

Therefore, based on the results given in Table 4, Table 5 and Table 6 also, it may be concluded that on the basis of two tehsils in the district, the %CV of the above estimates for overall size classes are quite reasonable indicating the feasibility of getting reliable estimates at district level.

5. CONCLUSIONS

In this study, a suitable sampling methodology aligned with existing Input Survey for estimation of private food grains stock at farm level has been developed. A suitable questionnaire aligned with existing Input Survey of Agriculture Census has been developed covering different food grains stock at farm level. The estimates of pre-harvest opening stock, production obtained, quantity sold, quantity stored, quantity disposed and percentage stock at farm level along with their %CV have been obtained based on two tehsils of Ratlam district of Madhya Pradesh and two tehsils of Karnal district of Haryana State under study.

Since, the estimates have been obtained based on two tehsils, the %CV is found to be high. It has been observed that it is feasible to obtain the reliable estimates of food grains stock and estimates of other parameters at farm level with its percentage coefficient of variation. Based on the results obtained for overall size groups, it is expected that the proposed methodology will provide farm level reliable estimates of food grains stock at district level. Based on this pilot study it is recommended that the questionnaire developed for this study covering different food grains stock at farm level may be included in Input Survey of Agriculture Census. This will bridge the gap on private food grain stocks in on-farm and off farm domains of the supply chain. The attempt to improve information on 'on-farm' food grain stocks

would not only contribute to bridging data gap for food stock measurement but would also augment farming information that have direct relevance to farm income and farm economy.

ACKNOWLEDGEMENTS

Authors are thankful to the reviewer for encouraging comments and valuable suggestions which has led to significant improvement in the paper.

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